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Teachers College Series



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J. R. McKAVNEY

Duquesne University



THE INTERRELATIONS OF MENTAL ABILITIES

BY

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SEP. 17 1958

SECTION I

THE TESTS AND THEIR ADMINISTRATION

Thirty-two kinds of tests were used in this study, comprising those listed on page 2. In general, two tests of each kind were given, similar in form but varying in content. In some cases only one test was given, it being divided arbitrarily into two halves for scoring. A1 and A2 were such *ex post facto* halves. So also were A3 and A4, B3 and B4, D3 and D4. In two cases the scores from four (or five) tests were consolidated into two scores, making A7 and A8, and E9 and E10. In five cases the same test was given the second time and both scores were used, making C3 and C4, C5 and C6, C7 and C8, E11 and E12, E13 and E14.

The subjects were the children of two classes, the 6B1 and the 6B2 of the Bronx Public School No. 51. The two class rooms were adjacent. The two teachers who taught these two classes used the departmental method of instruction, i.e., they divided the subjects to be taught equally between themselves and each taught her allotted subjects to both classes, both classes receiving exactly the same instruction. The two classes contained, at the time the writer began to make his tests, 37 boys and 46 girls. For various reasons, to be explained later, the records of only 31 boys and of only 38 girls were used in the composites and final calculations. The records of the two classes have not been kept separate, though the records of the two sexes have been carefully kept apart. Throughout the whole series of experiments the pupils showed marked interest and a strong desire to do good work. So far as pressure of work would permit, each day the writer read to the classes the results of the previous day's tests, that is, of the six or eight best in each class. As evidence of their interest it may be noted that the pupils showed admirable care of the mechanical tests, very few pieces being damaged or lost.

The tests were given during the spring semester of 1916. Those of the Ventilation Commission were given during February, March, and April, while the other tests were given during May and June. The former were given with notable care by expert psychologists. The latter were given either by the writer or in

THE ABILITIES MEASURED

		DISTINCT TESTS	DISTINCT SCORES
	Manipulative Tests		
A1 & A2	Stenquist Construction Test Single Series 1	1	2
A3 & A4	Stenquist Recognition of Mechanical Devices	1	2
A5 & A6	Knot Making Test	2	2
A7 & A8	Metal Puzzles	4	2
A9 & A10	Diagram Matching	2	2
A11 & A12	Diagram Drawing	2	2
A13 & A14	Handwriting	2	2
	Non-verbal Spatial Relations Tests		
B1	Rogers' Superposition	1	1
B2	Thurstone Spatial Relations	1	1
B3 & B4	Rogers' Locus or Space Intuition Test	1	2
B5	Briggs' Similar Figures	1	1
B6	Briggs' Congruent Figures	1	1
	Non-verbal Computational Tests		
C1 & C2	Bonser's 2A and 2B	2	2
C3 & C4	Woody Addition	1	2
C5 & C6	Woody Subtraction	1	2
C7 & C8	Woody Division	1	2
	Arithmetic Tasks Stated in Words		
D1 & D2	Bonser's 1A and 1B	2	2
D3 & D4	Starch's Arithmetic Scale	1	2
D5 & D6	Teachers College Arithmetic VI and VI(a)	2	2
	Very Verbal Tests		
E1	Briggs' Transitive Verbs 23	1	1
E2	Briggs' Phrases 24	1	1
E3 & E4	Starch's Grammatical Scales A and C	2	2
E5 & E6	Van Wagenen's Mixed Relations	2	2
E7 & E8	Woodworth and Well's Mixed Relations modified by Thorndike	2	2
E9 & E10	Thorndike's Reading Tests Alpha and I, J, K, L	5	2
E11 & E12	Thorndike's Directions V	1	2
E13 & E14	Thorndike's Visual Vocabulary Scale A	1	2
E15 & E16	Thorndike's Visual Vocabulary XII and VIII	2	2
E17	Thorndike's Visual Vocabulary IX	1	1
E18	Thorndike's Directions VII	1	1
	Logical Tests		
F1 & F2	Briggs' Faulty Arguments 37 and 39	2	2
F3 & F4	Briggs' Catches 41 and 42	2	2
		52	56

his presence. All tests were given to the children in any one class under the same conditions, as a group test. It was frequently impossible to give to each class the same test on the same day, since, for example, the Knot test required some 8 to 10 minutes for scoring each pupil. Six to eight hours' work on the test was therefore necessary before it was ready to be given the second time. The Construction test and each series of the Puzzle test likewise required several hours for scoring. The paper tests were given as far as possible to both classes on the same day. The administration began usually at 1:45 P.M. and closed about 2:50 P.M., that is, one-half hour for each class. Moreover, the order in which the classes were taken from day to day was alternately 6B1 and 6B2. The class-room teacher was usually present, but took no part in the administration of the tests.

GROUP A. CONSTRUCTION OR MECHANICAL OR MOTOR TESTS

A1 & A2 The Stenquist Construction Test Single Series 1
The time for the whole test is 30 minutes.

Source. This test has been devised by Mr. John Langdon Stenquist, a graduate student of Teachers College, who, however, has not published any articles on this particular test, though he has published several articles on other and similar tests.

Description. The material for this test is contained in a wooden box, 24 inches long, 5.5 inches wide and 2 inches high, fitted with hinges and containing eleven compartments, in each of which is a mechanical device, which is of full size and standard quality, but has been taken to pieces. The only tool needed is a screwdriver, and one of these is placed in each box.

Presentation. To each pupil is given a slip of paper upon which to write his name. He is instructed to place this slip in the box. Then to each pupil a box is given, which is placed before the pupil with the hinges toward him. He is told that when he opens the box he may use the cover for a tray in which to keep the pieces, and he is advised to take the pieces out of one compartment and to complete the device and put it back before he disturbs another. This advice is given to prevent the pieces from becoming mixed. He is told to begin at his left hand, and to work in order toward his right hand, and that the device is to be put together so that it will work properly. Then the signal is given

to begin. The usual signal in this and in all other tests in this series is: "Ready! Hands up! Go!"

Method of Scoring. For each device which is properly put together so that it will work correctly 10 marks are given. For partial success partial credit is allowed according to the subjoined scheme of marks. For the purpose of correcting for attenuation this test was scored in two parts. A1 represents the score for the alternate odd devices and A2 for the alternate even devices. The highest possible score is 110 marks for the whole test.

SCHEME FOR SCORING THE STENQUIST CONSTRUCTION TEST SINGLE SERIES 1

A Bicycle Wrench	Head right = 2, nut right = 8, nut toward handle = 4, nut toward head = 2, head wrong and nut right = 1, both wrong = 0.
B Ten Link Chain	Each right link = 1, each half looped link = ¼.
C Rubber Hose Clamp	Lever right = 10, lever reversed = 9, lever underneath = 3.
D Bicycle Bell	Lever right = 3, lever reversed = 1, spring right = 4, spring attached to wrong place = 2, cogwheel = 2, hammer = 1.
E Paper Clip	Both levers right = 10, one lever right and one reversed = 9, both levers reversed = 8, levers wrong end in spring = 2.
F Metal Money Safe	Center right = 2, center upside down = 1, the three springs = 1, each cap = 1, cover = 4.
G Spring Clothespin	Both levers right = 10, spring on tip of levers = 2.
H Gas Faucet	Tap right = 1, washer right = 2, washer reversed = 1, holding screw = 1, regulating screw properly working = 6.
I Electric Push Button	Peg = 1, spring = 1, base correctly fastened = 8.
J Door Deadlock	Lug = 1, bolt = 1, spring = 3, cover and screw = 1, key = 0, lug and bolt and spring = 0.
K Mouse Trap	Lever = 1, baitholder = 2, coil = 5, rivet = 0, complete trap = 10.

A3 & A4 The Stenquist Recognition of Mechanical Devices Tests

The time for this whole test is 30 minutes.

Source. As the name implies, this test, like A1 & A2, has been devised by Mr. Stenquist. Nothing has hitherto been published concerning this test.

Description. The test consists of a sheet of foolscap paper containing a space for the pupil's name, the date, etc., and a list of the names of fifty-five mechanical devices and also a stout cardboard box 18.25 inches long, 9.25 inches wide and 1.75 inches high. This box contains fifty-five mechanical devices corresponding to the names on the list. Each tool, which is of standard size and quality, is numbered and is fastened securely to the bottom of the box.

Presentation. To each pupil is given a sheet of paper and a box. When each one has written his name, the purpose of the test is explained. The pupil is to find the mechanical device in the box which corresponds to its name on the list and then to write on the list and opposite the name the number of the device. At the usual signal the pupils begin work.

Method of Scoring. For each device properly identified one mark is allowed. For the purpose of correcting for attenuation, this test was scored in two parts. A3 contains the devices numbered 1 to 28, inclusive, and A4 contains the devices numbered 29 to 55, inclusive. The highest possible score for the whole test is 55 marks.

A copy of the sheet used in this test is shown below:

DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

A3 & A4

RECOGNITION OF MECHANICAL DEVICES

Test I Series I

Name Age years, ...months.

Sex Grade School

———*a.* Bushing for packing nut of spark plug.
———*b.* Cabinet door hook.
———*c.* Carriage bolt.
———*d.* Catch for cabinet door hook.
———*e.* Central insulation for spark plug.
———*f.* Center punch.
———*g.* Common ten penny nail.
———*h.* Common washer.
———*i.* Coping saw blade.
———*j.* Cotter pin.
———*k.* Curtain rod fixture.
———*l.* Cut nail.
———*m.* Dowel screw.
———*n.* Drive hook.
———*o.* Drill.
———*p.* Eight penny finishing nail.
———*q.* Expansion lug nut.
———*r.* Flat head harness rivet.

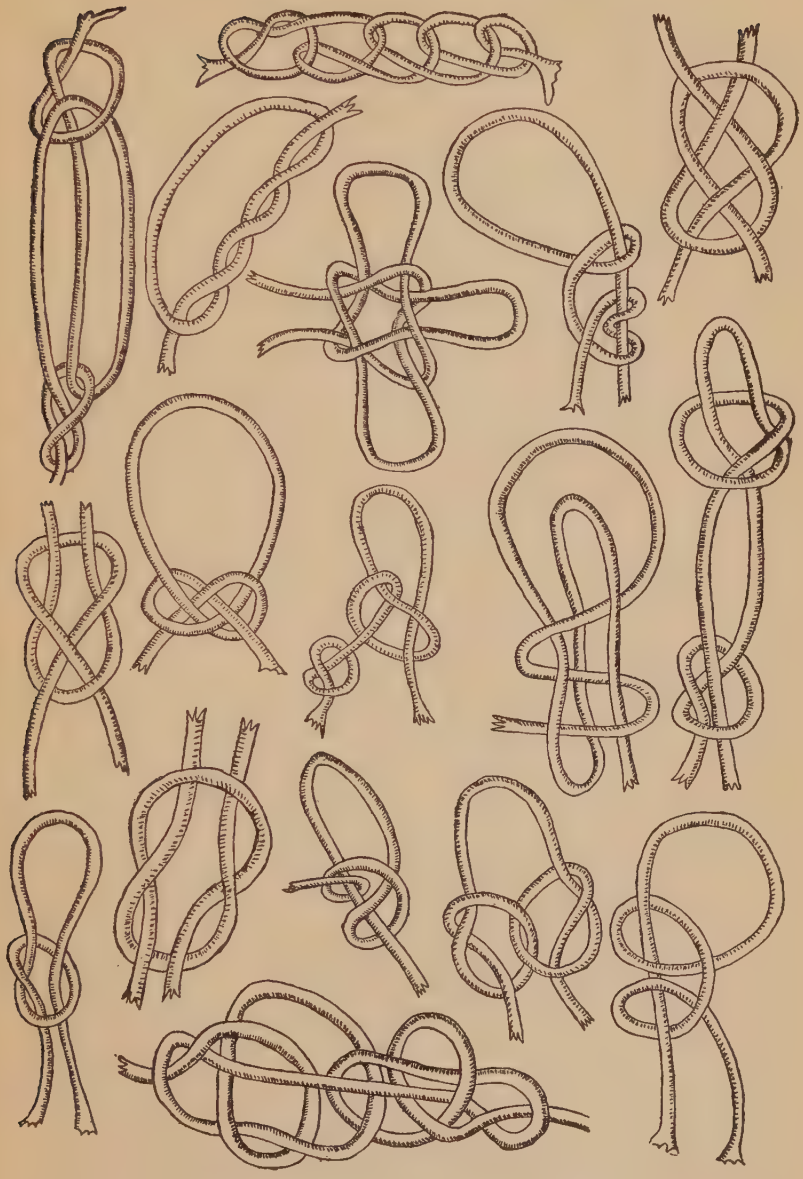
———*s*. Flat head wood screw.
———*t*. Fuse wire.
———*u*. Gasket or washer for making hose coupling tight.
———*v*. Gimlet.
———*w*. Glazier's point for fastening glass in window.
———*x*. Hack saw blade. x. Glass Cutter
———*y*. Hinge.
———*z*. Insulating plug for electric light wire in lamp.
———*a*1. Jam nut, or first nut for top of spark plug.
———*b*1. Lock washer.
———*c*1. Machine bolt.
———*d*1. Main body of spark plug.
———*e*1. Nail set.
———*f*1. Packing nut for spark plug.
———*g*1. Patent box or mitre frame fastener.
———*h*1. Picture nail.
———*i*1. Pipe reducer bushing.
———*j*1. Plumb bob.
———*k*1. Roller skate wrench and key.
———*l*1. Round head rivet.
———*m*1. Saw screw.
———*n*1. Shade fixture for non-revolving end of shade roller.
———*o*1. Shelf stop or support.
———*p*1. Set screw.
———*q*1. Small hasp.
———*r*1. Soft solder.
———*s*1. Staple for small hasp.
———*t*1. Stove bolt.
———*u*1. Tar paper nail cap, to prevent nail head from tearing paper.
———*v*1. Thumb nut.
———*w*1. Trunk caster.
———*x*1. Wedge to prevent window from rattling.
———*y*1. Wedge for tool handles.
———*z*1. Window sash fastener.
———*a*2. Window lift.
———*b*2. Window shade fixture for revolving end of shade roller.

A5 & A6 Knot Making Test. Ruger-Mandl Series I and Ruger-Mandl Series II

The time for each series is 30 minutes.

Source. This test has been designed by Professor Ruger, of Teachers College, and constructed by Mr. M. M. Mandl, a graduate student of the Department of Psychology in Columbia University, though the writer contributed some thought and energy to the selection of the knots and to the preparation of the material. Nothing has hitherto been published on these series.

Description. The material for this test is contained in a stout manilla envelope 12 inches long and 10 inches wide. Each envelope contains fifteen folders, each 11 inches long by 9 inches wide, numbered consecutively from 1 to 15, inclusive. Each



KNOT MAKING TEST. SAMPLES OF KNOTS.

folder contains upon its inside front cover a drawing of the knot to be made, and a loose piece of cardboard, 10.5 inches long by 7.25 inches wide, to which is attached, by two rubber bands, one piece of sash-cord if the knot to be made is single, and two pieces of sash-cord if the knot to be made is double. The knots to be made are arranged in the order of difficulty, as estimated from many preliminary trials.

Presentation. The two series were given on different days. To each pupil was given a slip of paper upon which to write his name, etc., and he was asked to place this paper in his envelope. The envelopes were then distributed and placed so that the flap was uppermost and toward the pupil's right hand. He was instructed upon opening the envelope to take out the top folder, to open it and to make with the piece of cord a knot like the

Series A5

Name	Number	Marks	Pieces of Cord	Length of Cord, Inches
Figure Eight	1	0 or 1	1	17
Slip	2	0 or 1	1	19
Hitch	3	0 or 1	1	24
Reef	4	0 or 1	1	24
	5	0 or 1 or 2	1	25
Double Bowline	6	0 or 2	1	34
Carrick Bend	7	0 or 2	2	11 each
Weaver's	8	0 or 2	1	34
	9	0 or 2	1	30
Granny	10	0 or 2	1	24
	11	0 or 3	1	30
Fisherman's	12	0 or 1 or 2 or 3	1	30
	13	0 or 1 or 2 or 3 or 4	1	30
	14	0 or 1 or 4	1	34
	15	0 or 2 or 5	1	34

Series A6

Reef	1	0 or 1	2	10 each
Hitch	2	0 or 1	1	20
Weaver's	3	0 or 1	2	10 each
	4	0 or 1	1	20
Hitch	5	0 or 1 or 2	1	19
	6	0 or 1 or 2	1	19
Granny	7	0 or 2	2	11 each
	8	0 or 2	1	23
Bowline	9	0 or 3	1	19
Carrick Bend	10	0 or 2	1	24
	11	0 or 2	1	19
Sheepshank	12	0 or 1 or 3	1	30
	13	0 or 2 or 4	1	28
Chain	14	0 or 1 or 2 or 3 or 4	1	34
	15	0 or 3 or 5	1	35

diagram and to place the knot upon the cardboard, fastening it there by the rubber bands; then to put the cardboard back into its folder and to put the folder back into the envelope underneath the others, and then to take another folder, etc.

Method of Scoring. Since the knots differ in difficulty the marks vary according to the subjoined scheme, the highest possible score being 35 marks for each series. (See page 8.)

A7 & A8 Ruger Puzzle Series I, II, III, IV

Series I.

The time for this series is 15 minutes.

Source. Puzzles Nos. 1, 2, 3, 4, and 5 were designed by Professor Ruger, of Teachers College, and were shaped and brazed by the writer in the workshops of Teachers College. Puzzle No. 6 was purchased ready made. Puzzles Nos. 7 and 8 were purchased and then modified by the writer.

Description. Each puzzle consists of two parts. One part of puzzle No. 1 is made of No. 7 wire and the other part is made of No. 10 wire. Puzzles Nos. 2, 3, 4, and 5 are made of No. 10 wire. Puzzle No. 6 consists of a finer wire. Puzzle No. 7 consists of a piece of sheet metal shaped like the conventional heart and pierced by six holes through each of which a cord is passed, and then looped and pulled taut. Puzzle No. 8 consists of a metal rectangle pierced by three holes through which a cord is passed and then looped and drawn taut. The ends of each cord are tied by a knot and the knot is secured by sealing wax. These eight puzzles are constructed largely on one principle. The eight are contained in a stout cardboard box 13.5 inches long, 6 inches wide and 1.25 inches high. The box has seven compartments, each containing one puzzle, except the seventh compartment, which contains two puzzles, i.e., puzzles Nos. 7 and 8. The compartments are numbered and the puzzles are arranged therein according to estimated difficulty.

Presentation. A slip of paper for the name, etc., and a box of puzzles were given to each pupil with instructions to separate each into two parts, without the use of force.

Method of Scoring. One mark was allowed for each puzzle which was separated into two parts without damage to the puzzle. The highest possible score is eight marks.

Series II.

The time for this series is 15 minutes.

Source. The metal parts of these puzzles were designed by Professor Ruger and shaped by the writer. The leather parts were made by a neighboring shoemaker.

Description. This series consists of three puzzles. The principle of the three is identical, but the second is much more difficult than the first, while the third is very much more difficult than the second. Each consists of two parts. One part is a leather band about one-fourth inch wide. The other part is made of No. 10 wire. The three puzzles are contained in a stout cardboard box 7 inches long, 5.5 inches wide and 1 inch high. Each box has three compartments, one for each puzzle.

Presentation. A slip of paper for the name, etc., and a box of puzzles were given to each pupil, with instructions to remove the leather strap from the metal part without the use of force.

Method of Scoring. Four movements are necessary for the solution of puzzle No. 1, nine movements for puzzle No. 2 and nineteen movements for puzzle No. 3. For each movement properly made one mark is allowed. Each pupil, however, returned the puzzles usually wholly apart or wholly together, therefore very few marks were given for partial solutions. The highest possible score is 32 marks.

Series III.

The time for this series is 30 minutes.

Source. These puzzles (Chinese rings) were purchased ready made, but were later modified by the writer.

Description. This series consists of five puzzles, all identical except in the number of the rings. Puzzle No. 1 has two rings, puzzle No. 2 has three rings, puzzle No. 3 has four rings, puzzles Nos. 4 and 5 have five rings each. In order to prevent the slipping of the frame carrying the rings, from the bar to the handle, and thus delaying and probably perplexing the pupil, a piece of strong string was tied around the narrow part, between the bar and the handle, and this string was protected by a thick covering of sealing wax. These five puzzles are contained in a box, similar in all respects to the box of series No. 1, except that the boxes for series No. 3 contain five compartments, which are numbered

from 1 to 5. The puzzles are arranged therein according to their difficulty. In order to prevent the rings from slipping wholly off the bar a paper clip, the same as in Test A1 & A2, was placed over the point of the bar.

Presentation. To each pupil were given a slip of paper for the name, etc., and a box of puzzles, with instructions to remove first the clip and then to separate, without damaging the puzzles, the frame carrying the rings from the bar, and then to place the clip back on the point of the bar. The purpose of the clip was carefully explained to the pupils.

Method of Scoring. For the solution of the two-ring puzzle, two movements are necessary; for the three-ring puzzle, five movements; for the four-ring puzzle, ten movements; and for the five-ring puzzle, twenty-one movements. For each movement properly made one mark is allowed. The highest possible score is 59 marks.

Series IV.

The time for this series is 30 minutes.

Source. These puzzles and their boxes were purchased ready made. Several of the puzzles were separated by the writer into their component parts and recombined.

Description. This series consists of fifteen puzzles. No two are alike, though three form one group differing only in the number and the arrangement of the parts, while four others form another group likewise differing only in the number or the arrangement of the parts. The boxes are 12.5 inches long, 7.75 inches wide and 1 inch high. Each box has fifteen compartments, that is, one compartment for each puzzle. All these puzzles are made of stout steel wire, nickel plated, except one which is made of cast iron.

Presentation. A slip of paper for the name, etc., and a box were given to each pupil, with instructions to separate the puzzles into their parts. The pupils were told that they might use force in separating any, except the puzzle which was made of cast iron. They were told that they might begin the puzzles in any order but were advised that the puzzles at their left hand were on the whole easier than those on their right hand.

Method of Scoring. The marks allowed varied partly according to the estimated difficulty and partly according to the number of easily distinguishable movements necessary for the complete solution. Two puzzles were allowed one mark each; two puzzles were allowed two marks each; five puzzles were allowed three marks each; four puzzles were allowed four marks each; one puzzle was allowed five marks; and one puzzle was allowed six marks. The highest possible score is forty-eight marks. Partial credit was allowed according to the number of correct moves which had been made.

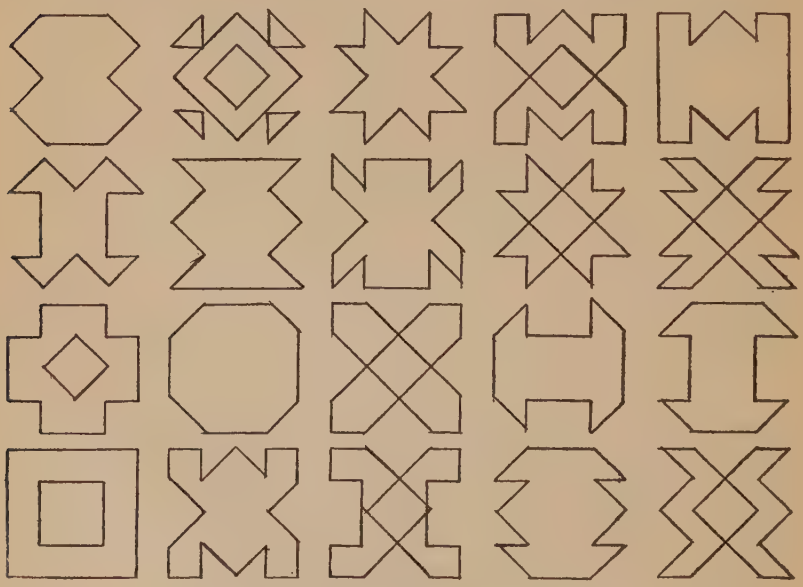
Test A7 consists of *Series I* and *Series IV*.

Test A8 consists of *Series II* and *Series III*.

A9 & 10 Diagram Matching Test, Two Series: A and B

The time for each of these two series is 14 minutes.

Source. The writer received the idea for this test and for the next succeeding test from the Binet-Simon series. The prototype is given by de Fursac (1913; pp. 437-38), as test No. 54. He calls it a test for imagery of form and assigns it to children



SECTION OF DIAGRAM MATCHING TEST.

of thirteen years. The prototype is given also by Goddard (1911, p. 9) in his revision under the title "Cutting Out," and he assigns it to adults. The writer's purpose was to obtain a non-verbal test for imagery of form, which (1) would be much easier than the Binet-Simon tests and which (2) could be given to a large group at one time, and which (3) could be easily scored. The test as modified seems to fulfill all these conditions.

Description. The two series of this test are similar and have been evolved on the same principle. They are of equal or of nearly equal difficulty, since the 100 diagrams which compose tests A9, A10, A11, A12 were drawn at one time in such a way that the 100 diagrams are really twenty-five groups of four each, these four being identical with each other except in orientation. For the Matching tests twenty groups were selected and from each group one was taken for series A9 and another was taken for series A10. The test consists of two sheets of paper. One sheet contains twenty diagrams, which are symmetrical, so far as their quarters are concerned. This sheet contains blank spaces for the name, etc. The other sheet contains the *Upper Left Hand Quarters* of the diagrams of the first sheet, but the order of the figures in the two sheets is quite different. The Upper Left Hand Quarters are numbered consecutively.

Presentation. Two diagrams, which are not in these series, were drawn on the blackboard, and also their Upper Left Hand Quarters. The tests were explained and described from the blackboard. The pupils were told that they would be required

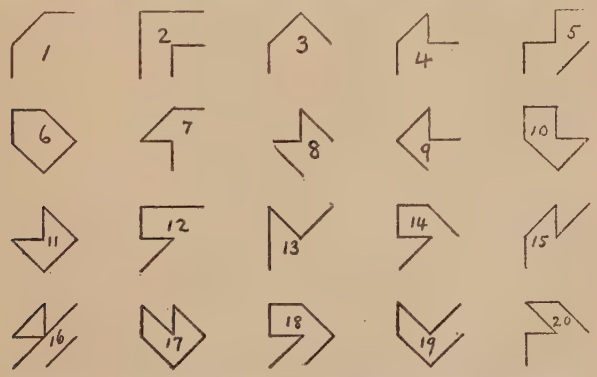


DIAGRAM MATCHING TEST. UPPER LEFT HAND CORNERS. quarters

to compare the figures on the two sheets and to select the whole diagram corresponding to the Upper Left Hand Quarter and to write in the whole diagram the corresponding number. These tests, like all the other paper tests, are given face down and at the usual signal are upturned and immediately the time is taken and the task of solution is begun. The two series were given on different days.

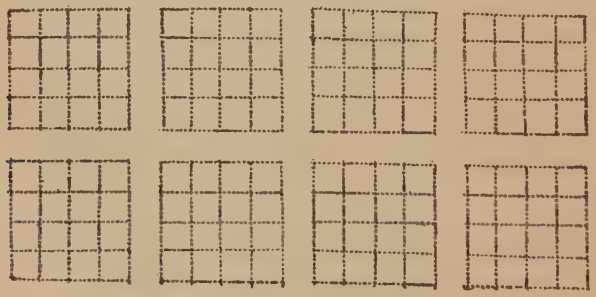
Method of Scoring. One mark was allowed for each diagram properly identified. No penalty was imposed for errors. In scoring, a shield was used having an opening corresponding to each whole diagram and properly numbered. This sheet, when laid on the sheet marked by the pupil, greatly facilitated the task of scoring and much diminished the chance of error. The highest possible score is 20 marks for each series.

A11 & 12 Diagram Drawing Test, Two Series: C and D

The time for each of these series is 30 minutes.

Source. See above for A9 & A10.

Description. The two series of this test are similar and have been evolved on the same principle. They are of equal or of nearly equal difficulty, since the sixty diagrams which remained when the forty diagrams of A9 & A10 were removed were equally divided. Two sheets were used for each pupil. The first sheet contains thirty figures. Each of these is the upper left hand quarter of the diagram to be drawn and bears its distinctive number. The second sheet has forty dotted outlines all alike. The purpose of these outlines is to form a background on which the pupils can draw the required diagram, thereby greatly simplifying the task for him and also much facilitating



SECTION OF DIAGRAM DRAWING TEST.

the labour of scoring. The diagrams are 1.5 inches long and the same in width. Each dotted outline has five equidistant lines parallel to the lower margin of the sheet, and five equidistant lines crossing these at right angles.

Presentation. The purpose of the test was explained to the pupils at the blackboard, upon which were drawn some diagrams from the previously described test. Some dotted outlines were drawn and then filled in from the patterns. The pupils were told that the extra outlines were for use in case they spoiled an outline and that they were not required to draw the diagrams according to the order of the patterns, but to be careful to write in their drawing the number of the pattern. The use of rulers was allowed but was not encouraged.

Method of Scoring. One mark was allowed for each diagram properly drawn. Neatness and beauty were not counted, since these tests are not of artistic ability, but of power to utilize ideas of form. To be correct, each angle must coincide with an intersection of the dotted lines in the background. Therefore subjective criteria for the appraisal of the drawing were wholly unnecessary. Two or three pupils left one diagram each incomplete. If this were correct partial credit might be given for it by a finer system of scoring, but the cases were so few as to cause but slight difference in the results. The highest possible score is 30 marks for each series.

A13 & 14 Handwriting

The material for this test was the papers belonging to the other tests. Two of the written tests were used for A13 and two other written tests were used for A14. These samples were graded by two persons. The Thorndike Handwriting Scale was employed as the standard. The highest mark on this scale is eighteen. The papers were graded by quarter marks. In order to avoid fractions these quarter marks were multiplied by four. Since the scores of the two judges were combined the highest mark possible for test A13 or A14 was $18 \times 2 \times 4 \times 2 = 288$. The highest mark actually given to any sample was 16. The pupils were advised to write legibly but on the whole very little emphasis was laid upon the handwriting portion of the series. The object

was to obtain, not the best copy-book style, but the best ordinary samples.

Group B. Non-Verbal Spatial Relations Tests

B1 Superposition Test

The time for this test was 2 minutes.

Source. This is a modification, for the sake of simplification, by Miss Rogers,[1] of Thurstone's Spatial Relations Test, which will be described in test B2.

Description. This test requires the recognition of plane geometrical figures, all being equal and symmetrical rhombuses, each side being one-half inch in length. Each rhombus has for one side a heavy line, which may make any angle with the margin of the paper, provided only that one side of the rhombus be parallel to some one margin of the paper. Twenty-four such rhombuses are arranged in two columns. Each contains a small circle in one corner, in any corner so far as the heavy line and the margin of the paper are concerned. Opposite to each of these rhombuses are two rhombuses without circles. These have the heavy line parallel with the base margin and toward it. Moreover, this heavy line is continuous between the two and projects about an eighth of an inch beyond each. The two upper corners of the two rhombuses are one-fourth of an inch apart, while the two lower corners are three-fourths of an inch apart.

Presentation. This test was given by Miss Rogers in the writer's presence. Explanations were given at the blackboard, and some practice was allowed before the material for the actual test was distributed. The pupils were required to find the one of the two rhombuses which corresponded to the rhombus with the circle and then to draw the circle in the corresponding corner.

Method of Scoring. One mark was allowed if the circle was placed in the proper diagram, and two marks were given if the circle was drawn not only in the proper diagram, but also in the proper corner. Nothing was allowed if the wrong diagram was marked. The highest possible score was 48 marks.

[1]Rogers, A. L., *Tests of Mathematical Ability and Their Prognostic Value,* Teachers College.

B2 Thurstone Spatial Relations Test

The time for this test is 2.5 minutes.

Source. This test was devised by Dr. L. L. Thurstone, of the Pittsburgh Institute of Technology.

Description. The test is the same in all respects as the Superposition test described above, except that before identifying the rhombus it must be imaginatively turned face downwards and back upwards.

Presentation. This test was given by Miss Rogers in the writer's presence. The test was explained at the blackboard and some time (1 or 2 minutes) was permitted for practice before the test sheets were distributed.

Method of Scoring. The same as in B1.

Instructions. Prepare three cardboards similar to the three cards shown on the instructions side of the sheet. Make these cards about 10 inches on the side. Paint one edge of each card black on both sides of the card. Cut the holes as indicated.

Before giving the test, draw on the blackboard the complete drawing on the instructions side of the blank. This need not be done very accurately.

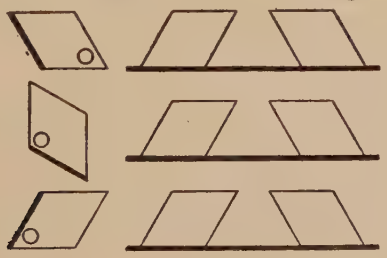
SPATIAL RELATIONS TEST

Assume that the lozenge shaped figure with a circle in it represents a small card with one of its edges painted black and with a hole in one corner.

Imagine that this card is picked up, turned over, and placed *face down* with the black edge of the card touching the long heavy black line to the right. Imagine the card moved along this black line until its edges fit the edges of one or the other of the lozenge shaped outlines.

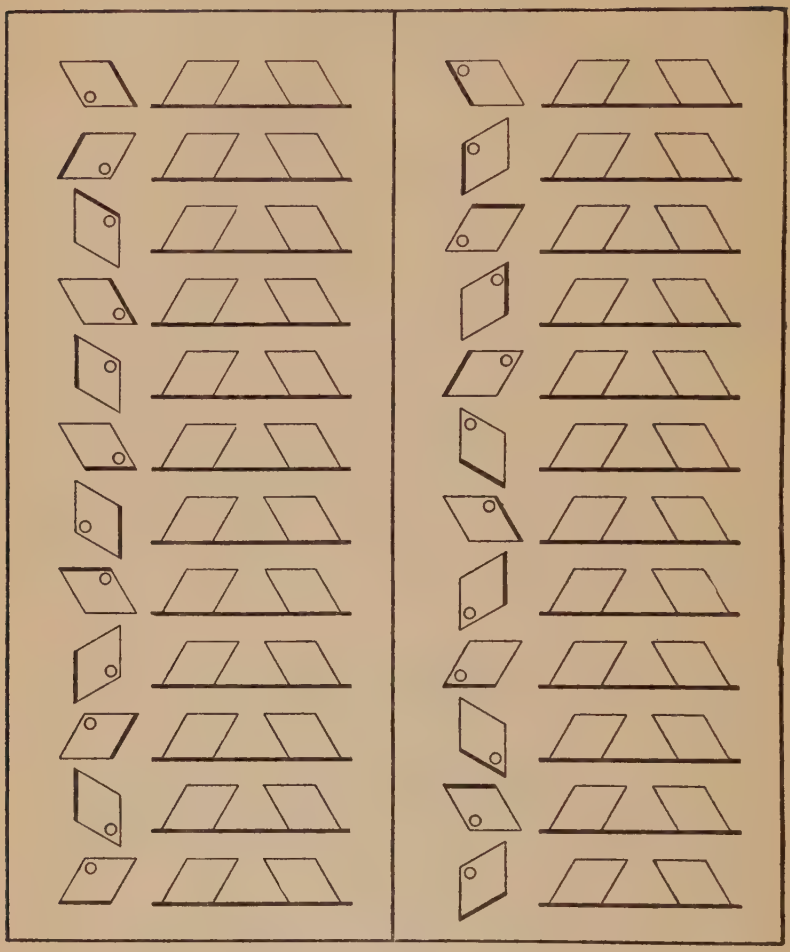
With your pencil *draw a circle in the corner where the hole will be.* Proceed in the same manner and as rapidly as you can with the remaining outlines on the page.

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TOP



Allow two minutes for the group to read the instructions, warning them that the instructions must be read carefully to be understood.

At the end of this time limit, repeat orally the marked portion of the instructions ("Imagine" . . . "hole will be") while

moving one of the large cardboards into place on the blackboard drawing. Give this paragraph verbatim for each of the three cards, on the instruction side.

Then give the test proper with a time limit of two minutes. I have found three subjects who finished the blank with 24 correct responses in less than the time allowed, but the majority of students make hard work of it and require considerably more than two or three minutes per column. If the test can be given as an individual test, it would be advisable to take the time for each column and thus obtain a reliability measure for the test. This is hardly practicable when giving it as a group test on account of the great range of speed.

B3 & B4 Locus Test or Space Intuition Test

The time for this test was not limited. Each pupil was permitted to work as long as he wished. The maximum time was 15 minutes.

Source. This test was prepared by Miss Rogers. Nothing has hitherto been published on this test.

Description. The paper, as given to the pupils, has two examples properly answered for the purpose of illustration and nine questions for the test. As the name implies the test is geometrical but unconventional.

Presentation. The test was given by Miss Rogers in the writer's presence.

Method of Scoring. For a perfect answer two marks are given and for an answer half right one mark is given. The highest possible score is 18 marks. For the purpose of correcting for attenuation the test was divided into two parts, though given as a whole. B3 consists of the alternate odd questions and B4 of the alternate even questions.

There is much doubt concerning the propriety of including this test in the non-verbal group, considering the age and training of the pupils tested. On the other hand, it is equally or more unsatisfactory to treat it as a very verbal test. Its complex nature should be kept in mind when its correlations are discussed.

Space Intuition Test (1)

Name Date.....

Example a) If a pencil moves on this paper 1 inch from the right-hand edge, draw the path followed by the point of the pencil. a.

b) Show by a drawing the kind of line that passes through all the houses one mile from a certain point. Let — = 1 mile. b.

1. A motor boat sails up a straight canal midway between the banks. Draw in the space opposite the path of the boat. 1.

2. Show by a drawing in the space opposite, the path of a point that is always half-way between the tip of the hour-hand of a watch and the rim. 2.

3. A number of equal circles are drawn between two parallel straight lines and touching them both. Show by a drawing in the space opposite where their centres must be. 3.

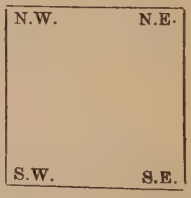
4. A pencil is attached to a string. The string and pencil are held as if a circle were to be drawn, but while the pencil moves round the fixed point at which the string is held, the string is gradually lengthened. Draw in the space opposite, the path marked by the pencil point. 4.

5. Draw in the space opposite, the path followed by the tips of a pair of shears, when the bolt or screw remains always fixed in one position. The scissors do not move forward or back. They simply open and shut. 5.



6. A boy starts from the southwest corner of a square and walks in a northeasterly direction. Draw in the space opposite, the path he follows.
 a) If for every foot he walks East, he walks 1 North.
 b) If for every foot he walks East, he walks 2 North.
 c) If for every foot he walks East, he walks ½ North.

6.



7. Show by a drawing in the space opposite, how a road would have to be constructed so as to be everywhere the same distance from two houses, A and B.

7. A B

B5 Similar Figures

The time for this test is 3 minutes.

Source. This test is No. 17 of Briggs' tests published in 1913.[1]

Description. The test consists of four odd figures and eight pairs of figures. The members of a pair are alike in all respects except in size or orientation. The twenty figures are arranged in five columns of four figures each. The members of a pair are never adjacent in a column or in a row.

Presentation. At the head of the sheet instructions are given: "Figures are similar when they are exactly alike in shape. Find pairs of similar figures and write in parentheses the numbers representing each pair, e. g., (21, 53)." Before the papers were distributed some oral instructions were given.

Method of Scoring. In order to avoid negative scores, 8 marks were added to each score. The highest possible score is 16 marks.

For each pair correctly marked	= 1
For error in the star figures	= —1
For each other error	= —2
For unattempted or meaningless	= —8

B6 Congruent Figures

The time for this test is 3 minutes.

Source. This test is No. 18 of Briggs' test.[2]

Description. This test consists of four odd figures and eight pairs of figures. The members of a pair are alike in all respects except in orientation. The twenty figures are arranged in five columns of four figures each. The members of a pair are never adjacent either in a column or in a row.

Presentation. At the head of the sheet instructions are given: "Figures are congruent when they are exactly alike in shape and size. Find pairs of congruent figures and write in parentheses the numbers representing each pair, e. g., (21, 53)." Before the papers were distributed some oral instruction was given.

Method of Scoring. The same as for B5.

[1] *Teachers College Record,* September, 1913, p. 25.
[2] *Ibid.,* p. 26.

Group C. Non-Verbal Computational Tests

C1

The time for this test was 6 minutes.

Source. This test is No. 11A as printed in Bonser (1910, p. 2) [1] and No. 35 in Briggs (1913, p. 34).[2]

Description. Dr. Bonser described this test as composed of one-step problems stated in a manner less conventional than usual, and regards them as a test of reasoning activity and of mathematical judgment. The test consists of five problems. Owing to a typographical error in Dr. Bonser's thesis this test is different from the form in which he gave it though agreeing with the book. The test here agrees with his book which reads "132 plus what number equals 36?" While his test as used by him read "32 plus what number equals 36?"

Presentation. This test was conducted in the same way as all other paper tests, except that the pupils were told that this test would be in arithmetic.

Method of Scoring. One mark was given for each correct answer. The highest possible score is 5 marks.

C2

The time for this test was 3 minutes.

Source. This test is No. 11B in Bonser (1910, p. 2) and No. 36 in Briggs (1913, p. 34).

Description. This test parallels C1 above.

Presentation. The same as in C1 above.

Method of Scoring. The same as in C1 above. The highest possible score is 5 marks.

C3 & C4 Addition

The time for this test was 25 minutes.

Source. This is a preliminary series prepared and used by Woody in the preparation of his Addition Scale (1916).[3]

[1] Bonser, F. G., *Reasoning Ability of Children in Grades 4, 5, 6,* Teachers College, 1910.

[2] *Teachers College Record,* September, 1913.

[3] Woody, C., *Measurements of Achievement in Arithmetic,* Teachers College, 1916.

Description. The test has 38 questions. It embraces the addition of one-place, two-place, three-place, and four-place integers, of decimal currency, of proper fractions, of mixed fractions, of decimals, and of compound numbers.

Presentation. This test was given twice, once in February and once in April.

Method of Scoring. One mark was given for each question which was answered correctly. The highest possible score was 38 marks.

C5 & C6 Subtraction

The time for this test was 20 minutes.

Source. The same as C3 & C4, in subtraction.

Description. This test has 35 questions. It embraces the subtraction of simple integers, of proper fractions, of mixed fractions, of decimals, and of compound numbers.

Presentation. The same as in C3 & C4 above.

Method of Scoring. The same as C3 & C4 above. The highest possible score was 35 marks.

C7 & C8 Division

The time for this test was 30 minutes.

Source. The same as C3 & C4, in division.

Description. This test has 36 questions. It embraces the division of simple integers, of decimals, of vulgar fractions, of mixed fractions, and of compound numbers.

Presentation. The same as in C3 & C4 above.

Method of Scoring. The same as in C3 & C4 above. The highest possible score was 36 marks.

These three tests are similar to but not identical with Series A, Woody (1916).

Group D. Arithmetic stated in Words

D1 & D2 Problems

The time for these two series is 3 minutes each.

Source. These are 1A and 1B in Bonser (1910, p. 2) and No. 33 and No. 34 in Briggs (1913, p. 33).

Description. Each test consists of five two-step problems.

Presentation. The same as in C1.

Method of Scoring. The same as in C1. The highest possible score is five marks for each series.

D3 & D4 Arithmetic Scale

The time for this whole test is 20 minutes.

Source. This test is by Dr. Daniel Starch (1916, p. 213).[1]

Description. This test consists of a graded series of problems of the sort ordinarily found in text-books.

Presentation. The same as in C1.

Method of Scoring. One mark was allowed for each correct answer. The twelve questions were given on one sheet and afterwards divided for the purpose of correcting for attenuation. D3 consists of the alternate odd questions and D4 of the alternate even questions. The highest possible score for the whole paper is 12 marks.

D5 & D6 Problems. Two Series: Tests VI and VI (a).

The time for these series was 30 minutes each.

Source. The Laboratory of Educational Psychology, Teachers College.

Description. Each series consists of six problems, which become progressively more difficult.

Presentation. The same as in C1.

Method of Scoring. One mark was allowed for each problem correctly answered. The highest possible score is 6 marks for each series.

TEST VI

Write your name here

Write the date here.....

Find the answers to these problems. Do all your work on the sheets of white paper. Write your answers here.

The answer to 1 is
The answer to 2 is
The answer to 3 is
The answer to 4 is
The answer to 5 is
The answer to 6 is

[1]Starch, D., *Educational Measurements*, 1916.

Write your name on every sheet of white paper that you use and hand in all the sheets of white paper.

1. There are 550 pupils on the roll. If 5/8 of them are here to-day, how many are absent?

2. A boy had 210 marbles. He lost 1/3 of them. How many were left?

3. The children of a school made small boxes to be filled with candy and given as presents at a school party. 600 were needed. In 4 days grades 3 to 7 made 20, 25, 83, 150 and 150 boxes. The eighth grade agreed to make the rest. How many did the eighth grade make?

4. A boy lost one-fourth of his kite string in a tree, one-third in some wire, and one-fifth in a hedge. What part of his string was left?

5. How much will 8¾ dozen pencils cost at the rate of $¼ for a half dozen?

6. John had $1.20 Monday. He earned 30 cents each day on Tuesday, Wednesday, Thursday and Friday. Saturday morning he spent one-third of what he had earned in four days. Saturday afternoon his father gave John half as much as John then had. How much did his father give John?

Test VI (A)

Write your name here

Write the date here

Find the answers to these problems. Do all your work on the sheets of white paper. Write your answers here.

The answer to 1 is
The answer to 2 is
The answer to 3 is
The answer to 4 is
The answer to 5 is
The answer to 6 is

Write your name on every sheet of white paper that you use and hand in all the sheets of white paper.

1. If $1991 a day is paid to 724 men who each earn the same wages, how much does each man receive?

2. A baseball team played 160 games during the season and won 100 of them. What part of the whole number of games did the team win?

3. A store-keeper sold 12 yards of cloth, which was 4/15 of the whole piece. How many yards were there in the whole piece?

4. A grocer had a tank holding 44 3/16 gallons of oil. One day he drew out 15¾ gallons and the next day 9⅞ gallons. How many gallons were left in the tank?

5. One summer a farmer hired 43 boys to work in an apple orchard. There were 35 trees loaded with fruit, and in 57 minutes each boy had picked 49 apples. If in the beginning the total number of apples on the trees was 19,677, how many were there still to be picked?

6. A boy had 3 dollars. He paid it all for four articles, which we will call A, B, C. and D. B cost as much as C. C cost as much as D. A cost as much as B, C and D together. The boy sold A and B for 1½ times what he paid for them. He sold C and D for 1¼ times what he paid for them. How much did he get for the four articles?

Group E. Very Verbal Tests

E1. Understanding and Applying a Definition: Transitive Verbs

The time for this test was 1 minute, 30 seconds.

Source. This test is No. 23 in Briggs (1913, p. 28).

Description. This test consists of twelve simple sentences. Nine of them have a transitive verb in the active voice. One each of the other verbs is intransitive or copulative or passive.

Presentation. Since the pupils had not received any school training in transitive verbs, the writer fearing that they would be confused by the printed instructions modified them to read "Mark the sentences with objects," i. e., 1, 2, 3, 7, 8, 9, 10, 11, 12. The papers were thus scored and the results used herein. Since this modification may have increased the confusion the papers were scored also by the original method, i.e., 1, 2, 7, 11, and the correlations with E2 were computed. These are: boys +25 and girls —01. The original method gives a slightly higher correlation than the modified method, though the average marks received by the pupils are much lower: boys 6.28 and girls 6.90.

Method of Scoring. One mark was allowed for each sentence containing a transitive verb in the active voice which was checked and one mark for any other sentence which was not checked. The highest possible score is 12 marks.

E2 Understanding and Applying a Definition: Phrases

The time for this test was 2 minutes.

Source. This test is No. 24 in Briggs (1913, p. 29).

Description. The test consists of twelve sentences. Four of these sentences contain a phrase according to the instructions given as stated below.

Presentation. At the top of each sheet two paragraphs are printed: "*A phrase* is a group of words not containing a subject and predicate and used like an adjective or an adverb.

"Make a ✓ by each sentence which, according to this definition, contains between the parentheses a phrase and nothing beside the phrase and its modifiers."

Method of Scoring. One mark was allowed for each sentence which was checked correctly and one mark for each other which was left unchecked. The highest possible score is 12 marks.

E3 & E4 Grammatical Scales: A and C

The time for A was 12 minutes and for C 6 minutes.

Source. These tests are by Starch (1915, p. 615 and p. 620).[1]

Description. Scale A contains 37 sentences and Scale C 20 sentences of various degrees of difficulty. Each sentence contains two or more words in parentheses between which choice is to be made. One of these alternatives is right and the other is wrong.

Presentation. At the top of the paper for each scale directions are printed as follows: "Each of the following sentences gives in parentheses two ways in which it may be stated. Cross out the one which you think is incorrect or bad. If you think both are incorrect cross both out. If you think both are correct underline both." These instructions were explained before the papers were distributed.

Method of Scoring. One mark was allowed for each sentence which was properly lined. The highest possible score for scale A is 37 marks and for scale C is 20 marks. The key supplied by Dr. Starch was invariably followed, though, in the writer's opinion, some of the usages thus scored wrong are allowable.

E5 & E6 Mixed Relations. Two Series

The times was about 1 minute, 15 seconds for each half of each series.

Source. The two series are developments of the Woodworth-Wells test, made by Mr. M. J. Van Wagenen, of the University of Minnesota. Nothing has hitherto been published upon these two series.

Description. Three words are read and the pupils are required to write the fourth word which must bear the same relation to the third word which the second bears to the first word. Each series consists of fifty such groups.

[1] *Journal of Educational Psychology,* December, 1915.

VAN WAGENEN MIXED RELATIONS TEST — C

Directions—Give at the rate of 5 seconds each—½ second between each word and 4 seconds for the written response.

1	Light	day	Dark
2	Birds	fly	Fish
3	Chalk	white	Carbon
4	Sun	shines	Wind
5	Summer	hot	Winter
6	Cats	scratch	Bees
7	Emerald	green	Ruby
8	Water	drink	Air
9	Father	son	Mother
10	Hat	head	Shoe
11	Chair	wood	Stove
12	Fast	fastest	Great
13	Cup	saucer	Knife
14	Man	husband	Woman
15	Write	stories	Draw
16	Lamp	oil	Stove
17	Daily	newspaper	Monthly
18	Hair	black	Eyes
19	Food	eat	Books
20	Clothes	tear	Dishes
21	Air	birds	Water
22	Barn	hay	Library
23	Month	week	Day
24	Far	near	There
25	July	month	Friday
26	Opaque	wood	Transparent
27	Thermometer	temperature	Clock
28	Potato	vegetable	Veal
29	Light	dark	Dry
30	Sight	blind	Hearing
31	City	mayor	State
32	Slipper	shoe	Cap
33	Present	known	Future
34	Work	problems	Play
35	Water	glass	Coffee
36	Factory	workman	Store
37	Fat	heavy	Thin
38	Bread	flour	Candy
39	Live	die	Life
40	After	before	Earlier
41	Sparrow	bird	Mosquito
42	Picture	frame	Field
43	Happy	laugh	Sad
44	Ounce	pound	Inch
45	Mail	write	Telephone
46	Complex	difficult	Simple
47	Linen	cool	Wool
48	Victory	defeat	Success
49	Cheap	many	Costly
50	Pencil	write	Broom

Presentation. These tests were given by Mr. Van Wagenen in the writer's presence. In addition to the directions printed at the top of the sheet, some oral explanations were given; these,

however, were few since the pupils had had some experience with similar tests. A few minutes rest was allowed between each half. At the end of each half, another triad (25b and 50a) was given, being any one of the preceding except the next preceding,

VAN WAGENEN MIXED RELATIONS TEST — D

1	Work	day	Sleep
2	Vinegar	sour	Sugar
3	Rain	summer	Snow
4	Year	month	Week
5	Iron	heavy	Aluminum
6	Rose	bush	Oak
7	Country	road	City
8	Eat	food	Wear
9	Horn	blow	Bell
10	High	low	Near
11	Water	liquid	Ice
12	Stove	heat	Lamp
13	Snow	sledge	Ice
14	Rugs	floor	Pictures
15	Boston	city	Kentucky
16	Silver	tarnishes	Iron
17	Hard	soft	Rough
18	Triangle	three	Square
19	Delicious	taste	Fragrant
20	Number	figures	Word
21	See	colors	Hear
22	Box	wood	Bottle
23	Fruit	basket	Water
24	Front	back	Top
25	Foot	ankle	Hand
26	Raise	lower	Open
27	Much	more	Good
28	Foot	leg	Hand
29	Sugar	bowl	Milk
30	Navy	sailors	Army
31	River	Hudson	Mountain
32	Coal	black	Gold
33	Hair	goat	Wool
34	Grain	wheat	Fruit
35	Leg	knee	Arm
36	Park	play	School
37	Baker	bread	Bees
38	Wall	paper	Floor
39	People	house	Birds
40	Sit	sat	Fly
41	Bright	colors	Loud
42	Park	gate	House
43	Man	legs	Carriage
44	Lilac	shrub	Fern
45	Violet	odor	Red
46	Under	over	Down
47	Kettle	utensil	Chair
48	Fire	warms	Ice
49	Fork	tine	Knife
50	April	March	Tuesday

in order to make the time limits as abrupt for triads 25 and 50 as for any other.

Method of Scoring. One mark was allowed for each correct response. The highest possible score for each series is 50 marks.

E7 & E8 Mixed Relations. Two Series

The time for these tests was 9 minutes each.

Source. An extension of the Woodworth-Wells test by Dr. E. L. Thorndike. Woodworth and Wells (1911, p. 64).[1]

Description. These are in general similar to tests E5 & E6. Each series contains 40 groups of words.

Presentation. To each pupil was given a sheet of paper containing the forty groups of words. Opposite each group was a blank space large enough to hold the fourth word. At the top of each paper of each series instructions were printed thus: "Write in each line a fourth word that fits the third word in that line in the way that the second word fits the first, as shown in the first three lines."

color—*red*	name—*John*
page—*book*	handle—*knife*
fire—*burns*	soldiers—*fight*

The presentation of these two series differs from the presentation of tests E5 & E6 in that in these two it was wholly visual while in tests E5 & E6 it was oral and auditory. Test E7 was given in February and test E8 was given in April.

Method of Scoring. One mark was given for each correct response. The highest possible score for each series is 40 marks.

E9 & 10 Reading Tests. Two Series: Alpha and I, J, K, L

The time allowed was as follows:—Alpha, 30 minutes; I, 5; J, 10; K, 10; L, 15.

Source. Test E9 is Thorndike's original Scale Alpha (not the well-known Alpha 2), for Measuring the Understanding of Sentences. Test E10 consists of similar material but much harder to read, and is designated I, J, K, L. (Sept. 1914, pp. 44, 60-64).[2]

[1] *Psychological Review Monographs,* vol. 13, 1911.
[2] *Teachers College Record,* September, 1914.

Description. Scale Alpha (Test E9) has four paragraphs (the third and the fourth being the same), after each of which some questions are asked. Scales I, J, K, L have each one paragraph and are followed by five, seven, eight, and eight questions respectively.

Presentation. Test E9 was given in February. Test E10 was given at one time in April. Above each paragraph instructions are given thus: "Read this and then write the answers. Read it again as often as you need to."

Method of Scoring. Each correct answer received two marks; each answer nearly but not quite correct received one mark; other answers received no mark. The highest possible scores are Alpha 32 and I, J, K, L 56.

E11 & E12 Directions V

The time for this test was 5 minutes.

Source. This test is by Dr. Thorndike (Sept. 1914, p. 38).[1]

Description. Ten commands are given to the pupils to be executed by them with a pencil on the given sheet of paper.

Presentation. The pupils were told that this was a Directions test and were asked to follow the printed instructions. Extensive explanations were unnecessary since the pupils had had experience with this sort of test. The same test was given twice but on different days.

Method of Scoring. One mark each was given for a correct response to Directions 1, 2, 3, 4, 8. Two marks each were given for a correct response to Directions 5, 6, 7, 9, 10. If one of these five was not wholly right but more than half right, one mark was given for it. The highest possible score is 15 marks.

E13 & E14 Visual Vocabulary

The time for this test was 30 minutes each.

Source. This test is Thorndike's original Reading Scale A, Visual Vocabulary (not the well-known Reading Scale A2, Visual Vocabulary) (Sept. 1914, p. 3).

[1] *Loc. cit.*

Presentation. This test was given twice. The instructions are printed at the top of each paper: "Look at each word and write the letter F under every word that means a *flower*," etc.

Method of Scoring. This was in terms of penalties. Score = Errors + Omissions. For the purpose of comparison with the other tests the deviations from these marks had their positive and negative signs transposed. The plus signs were made minus and the minus signs were made plus. The highest possible merit score is 43 marks.

E15 & E16 Visual Vocabulary. Two Series: XII and VIII

The time for each series is 25 minutes.

Source. These two tests are by Thorndike (Sept. 1914, pp. 27 and 29).

Description. These are similar to tests E13 and E14 except that only four rubrics are used. Test E15 (XII) has 104 words. Test E16 (VIII) has 100 words. These words are not arranged in groups and only roughly in the order of difficulty.

Presentation. Instructions are printed at the top of each sheet similar to tests E13, E14 and E17.

Method of Scoring. Same as in tests E13 and E14. The highest possible merit score is 104 marks for test E15 and 100 marks for test E16.

E17 Visual Vocabulary IX

The time for this test is 15 minutes.

Source. This test is by Thorndike (Sept. 1914, p. 27).

Description. This test is similar to E13, E14, E15 and E16. One hundred and thirty words are given. These differ widely in degree of commonness; only four rubrics are used.

Presentation. This is the same as for tests E13, E14, E15, and E16.

Method of Scoring. One mark was allowed for each word correctly denoted. The highest possible score is 130 marks.

E18 Directions VII

The time for this test is 10 minutes.

Source. This test is by Thorndike. Nothing has hitherto been published upon it.

Description. Twelve commands are given to the pupils to be executed by them with pencils on the given paper. The fulfillment of the commands depends on the knowledge of certain words.

Presentation. The pupils were told that this was a Directions test and were asked to follow the instructions which were printed at the top of the sheet.

Method of Scoring. Same as in tests E13 & E14. The highest possible merit score is 54 marks.

Two samples (21 the easiest and 32 the hardest) of the questions are given below:

Do what it says to do.

21. Show by a cross which costs most: an orange a suit of clothes a pair of skates a pound of sugar .

32. Show by a cross each word that means *"to make clear"* or something like *"to make clear"*:

execrate	expound
clarify	traduce
elevate	extort
satisfy	explain
elucidate	antipathy

Group F. Logical Tests

F1 & F2 Faulty Arguments. Two Series

The time for each of these is 5 minutes.

Source. These are tests No. 37 and No. 39 Briggs (1913, pp. 34-35).[1]

Description. Each series consists of four arguments. Three of these are invalid and one is valid.

Presentation. At the top of each sheet are given instructions thus:—"Some of these arguments are faulty. Find each one that is unsound and in the blank space below it briefly tell why." These instructions were supplemented by some oral explanations.

Method of Scoring. One mark was given for each fallacy explained. If the valid argument was left untouched and the others were attempted one mark was given for it. The highest possible score for each series is 4 marks.

[1] *Loc. cit.*

F3 & F4 Catches. Two Series

The time for F3 is 5 minutes and for F4 is 6 minutes.

Source. These are tests No. 41 and No. 42 Briggs (1913, p. 36).

Description. Each series consists of five statements, each of which contains some impossibility.

Presentation. At the top of each sheet are given instructions thus: "In each of the following sentences there is a 'catch.' Tell where the nonsense in each case is." These instructions were supplemented by some oral explanations.

Method of Scoring. In F3 for each nonsensical sentence exposed, one mark was given. In F4 one mark each was allowed for 1, 2, and 5, and two marks each for 3 and 4. The highest possible score for F3 is 5 marks and for F4 is 7 marks.

The Statistical Treatment of the Scores

1. The tests were in general treated as six groups according to the similarities of the tests.

Group A. Mechanical or Motor or Constructive.
Group B. Non-Verbal Spatial Relations.
Group C. Non-Verbal Computational.
Group D. Arithmetic stated in words.
Group E. Very Verbal.
Group F. Logical.

These names are not adequately descriptive, nor, in the case of F, exactly appropriate, but are used for convenience. All that is implied by any one of them is the reference to the group of tests themselves. Words, for example, are involved to some extent in the so-called Test of Non-Verbal Spatial Relations; the tests of Diagram Matching and Diagram Drawing are not so strictly mechanical or constructive as the Assembling tests. The grouping, however, is probably the most significant single grouping to make. From data to be given later in this monograph, a critic may regroup in any desired way.

2. The records of the two sexes have been kept apart and treated separately.

3. Every test in a given group has been correlated by the Bravais-Pearson "product-moments" method (formula *d*) with every other test in that group. The record of every pupil who was present in both the tests to be correlated, was retained. The record of a pupil who was absent from one or both the tests, was omitted. For these correlations see Tables 49 to 56.

4. These correlations have been modified for attenuation by the formula (*e*), that is, using geometrical averages or when negative correlations made the use of geometrical averages impossible by the formula (*f*), that is, using the arithmetical averages. Though the geometrical average is always smaller than or equal to the arithmetical average, yet a modification for attenuation by the geometrical average is not necessarily smaller than a modification made by the arithmetical average, since the difference between the two denominators may be equal to, or greater than, the difference between the two numerators. For these modified correlations see Tables 57 to 62.

5. The Average Deviations for each test were calculated and the sum of the average deviations for both parts of each pair for both sexes was found, and this sum was employed as a basis of calculation for the weights to be allowed for each test in the composites. One exception was made. The sums of the average deviations of tests E17 and E18 were computed separately. For these average deviations and their sums and the weights allowed see Table 13.

6. Six Composite Scores for each individual have been computed, weight being given as above described.

7. The correlations of these composites one with another have been computed. See Tables 5 and 6.

8. These correlations have been modified for attenuation. See Table 65.

9. Each group of correlations has been tabulated in rows and in columns. (See Tables 49 To 65)

10. Each column of the raw correlations of the composites for the boys has been correlated with every other column. The same procedure has been followed for the girls. The correlations (*Rab*) are given in Tables 20 and 21.

11. Each of these correlations (*Rab*) has been corrected by Spearman's formula (*j*) and these corrected correlations (*R'ab*) are given in Table 28. Concerning these formulae (*rab, Rab,* and

R'ab) Dr. Spearman writes (1914, p. 109): "The significance of *Rab* is by no means confined to the present problem. In particular, its relations to *rab* are most interesting: the one may easily be positive when the other is negative, or vice versa. For many purposes, *Rab* seems to be the more important value of the two. . . . The question arises, whether or not the coefficients should be corrected for 'attenuation' before calculating *Rab*. The matter is simplified by the easily demonstrable fact that if *Rab* is = 1 for the corrected coefficients, it must be so for the uncorrected ones also, and vice versa. And even if *Rab* has any other value, it will not in general be appreciably modified by correcting for 'attenuation' (the statement sometimes made that the hierarchy tends to be much better for uncorrected than for corrected coefficients is erroneous). The correcting process has the disadvantage of greatly complicating equation *R'ab*."

FORMULAE

m	= a measure of an individual in a test.
n	= the number of individual m's in a group.
S or Σ	= Summation.
A	= Arithmetic average.
x or y	= the deviation of any m from A.
A. D.	= Average Deviation from A.
S.D. or σ	= Standard Deviation.
r	= Correlation according to the "Product-moment" method.
P. E.	= Probable Error, or Sampling Error: used only when an inference is drawn from the particular to the general.
Rab	= The Correlation of the respective correlations in two columns.
$R'ab$	= Rab corrected for the Sampling Errors of ρax and ρbx by the Spearman formula (j).
ρax	= Deviation of each value of rax from the mean of rax.
ρbx	= Deviation of each value of rbx from the mean of rbx.
Σax	= P.E. of rax.
Σbx	= P.E. of rbx.
$\sigma^2 ax$	= mean value of $\Sigma^2 ax \div .6745^2$.
$\sigma^2 bx$	= mean value of $\Sigma^2 bx \div .6745^2$.
$\sigma ax\ \sigma bx$	= mean value of $\Sigma ax\ \Sigma bx \div .6745^2$.

FORMULAE

Arithmetic Average $= \Sigma mn$ (*a*)

A.D. = Arithmetic $\Sigma x/n$ or Arithmetic $\Sigma y/n$ (*b*)

σ or S.D. $= \sqrt{\frac{\Sigma x^2}{n}}$ or $\sqrt{\frac{\Sigma y^2}{n}}$ or $\sqrt{\frac{\Sigma m^2}{n} - A^2}$ (*c*)

$$r_{xy} = \frac{\Sigma(+xy) - \Sigma(-xy)}{\sqrt{\Sigma(x^2) - \Sigma(y^2)}} \text{ or } \pm \frac{\sigma^2_{x+y} - \sigma^2_x - \sigma^2_y}{2\sigma_x\sigma_y} \quad (d)$$

Modifying formula for attenuation using geometrical averages $\left.\right\}$ $r^4_{xy} = \frac{r_{x_1 y_1} \cdot r_{x_1 y_2} \cdot r_{x_2 y_1} \cdot r_{x_2 y_2}}{(r_{x_1 x_2} \cdot r_{y_1 y_2})^2}$ (*e*)

Modifying formula for attenuation using arithmetical averages $\left.\right\}$ $r_{xy} = \frac{r_{x_1 y_1} + r_{x_1 y_2} + r_{x_2 y_1} + r_{x_2 y_2}}{2(r_{x_1 x_2} + r_{y_1 y_2})}$ (*f*)

$$\text{P.E. of } r = \pm \frac{.6745(1 - r^2)}{\sqrt{n}} \quad (g)$$

$$r = \pm \sqrt{\frac{\sqrt{n}}{.6745}\left(\frac{.6745}{\sqrt{n}} - \text{P. E.}r\right)} \quad (h)$$

$$R_{ab} = \frac{\Sigma(\rho_{ax}\ \rho_{bx})}{\sqrt{\Sigma(\rho^2_{ax})\Sigma(\rho^2_{bx})}} \quad (i)$$

$$R^1_{ab} = \frac{\Sigma(\rho_{ax}\rho_{bx}) - (n-1)\,r_{ab}\overline{\sigma_{ax}\sigma_{bx}}}{\sqrt{\left\{\Sigma(\rho^2_{ax}) - (n-1)\overline{\sigma^2_{ax}}\right\}\ \left\{\Sigma(\rho^2_{bx}) - (n-1)\overline{\sigma^2_{bx}}\right\}}} \quad (j)$$

$$\text{P.E.}_\sigma = \pm \frac{.6745}{\sqrt{2\,n}} \quad (k)$$

(*l*)

$$\text{P.E.}_{average} = \text{P.E.}_{true\ average} - \text{P.E.}_{obtained\ average} = \frac{.6745\sigma \text{ distribution}}{\sqrt{n}}$$

SECTION II

THE NATURE OF THE ABILITIES MEASURED: THE INTERRELATIONS OF THE SEVERAL TESTS

The Manipulative or Mechanical Tests

The abilities measured by the Manipulative tests are not by any means identical. The notes which follow are based upon Tables 1 and 2. All correlation numbers are hundredths.

Tests A1 & A2 (Stenquist Construction or Assembling Test) require synthetic ability. The subject must be able to pick up two or more pieces and to combine them, without any pattern, into a workable whole. Symbols of all kinds are omitted. The subject may succeed with some of these devices by the method of trial and error, but he is much more likely to succeed if he recognizes the device and knows its use and the way it looks when it is properly united. The average correlations of this pair with the other Manipulative tests, excluding handwriting, are only +25 (raw) and only +47 (modified), while the average reliability coefficient is +49. Assembling correlates with one of the others half as well as it does with itself.

Tests A3 & A4 (Recognition of Mechanical Devices) require some knowledge of names, some knowledge of mechanical devices, and some slight ability to reach a conclusion by the method of exhaustion. This pair does not require any motor or manipulative skill. The average correlations of this pair with the other members of the group, excluding handwriting, are only +19 (raw) and only +33 (modified), while the average reliability coefficient is +59. It correlates with one of the others only one third as well as it does with itself.

Tests A5 & A6 (Knot Making) require synthetic ability. The subject does not need any knowledge of words, but he must be able to understand a pattern and to apply the pattern to concrete substances. He needs also some power of visual imagery and some manual dexterity. The average correlations of this pair with the other members of the group, excluding handwriting, are only +31 (raw) and only +50 (modified), while the average reliability coefficient is +65. It thus correlates with one of the others about half as well as it does with itself.

TABLE 1—INTERRELATIONS OF THE MANIPULATIVE TESTS

Averages of Boys' and Girls' Average Raw Correlations

	Stenquist Construction or Assembling	Recognition of Mechanisms	Knot Making	Metal Puzzles	Diagram Matching	Diagram Drawing	Handwriting
	A1&A2	A3&A4	A5&A6	A7&A8	A9&A10	A11&A12	A13&A14
A1 & A2.....	..	30	30	27	27	12	—22
A3 & A4.....	30	..	15	22	14	16	—16
A5 & A6.....	30	15	..	22	39	48	—20
A7 & A8.....	27	22	22	..	22	14	—02
A9 & A10.....	27	14	39	22	..	32	03
A11 & A12.....	12	16	48	14	32	..	—05
	126	97	154	107	134	122	—62
Averages	25	19	31	21	27	24	—10
	A1&A2	A3&A4	A5&A6	A7&A8	A9&A10	A11&A12	A13&A14
Reliability Coefficients...	49	59	65	32	52	80	64

TABLE 2—INTERRELATIONS OF THE MANIPULATIVE TESTS

Averages of Boys' and Girls' Correlations Modified for Attenuation

	A1&A2	A3&A4	A5&A6	A7&A8	A9&A10	A11&A12	A13&A14
A1 & A2.....	..	57	50	63	50	16	—36
A3 & A4.....	57	..	22	44	24	18	—24
A5 & A6.....	50	22	..	46	70	64	—30
A7 & A8.....	63	44	46	..	46	25	—04
A9 & A10.....	50	24	70	46	..	49	12
A11 & A12.....	16	18	64	25	49	..	—07
	236	165	252	224	239	172	—89
Averages	~~25~~ 47	~~19~~ 33	~~31~~ 50	~~21~~ 45	~~27~~ 48	~~24~~ 34	~~—10~~ —15

Tests A7 & A8 (Puzzles) require analytic ability. The subject does not need any knowledge of words more than that required to understand instructions. He does not need to know the purpose of the devices, in fact they have none except to perplex him. The simpler puzzles may be solved by merely fumbling with them, but the more complex puzzles require some insight into their construction. The subject does not need any knowledge of patterns or of mechanical instruments. He can clearly see the whole of each component part. He needs to know only the method by which the parts can be separated. The puzzles of the three graduated series measure, to some extent, the subject's learning ability, since if he recognizes the principle underlying the first puzzle in a graduated series and can use to advantage this knowledge, he will find the succeeding puzzles much simpler than they otherwise would be. If he fails to recognize the principle then he must proceed under increasing difficulties as the puzzles become more complicated. The average correlations of this pair with the other members of the group, excluding

handwriting, are only +21 (raw) and only +45 (modified), while the average reliability coefficient is +32. This is much the lowest reliability coefficient of the group. Its smallness is due probably to the element of chance which enters so largely into all kinds of puzzle tests. This reliability coefficient agrees closely with the findings of Burt and Moore (1912, p. 375),[1] who report a reliability coefficient of +30 for wire puzzles. The test thus correlates two thirds as well with one of the others as it does with itself.

Tests A9 & A10 (Diagram Matching) require analytic ability. The easiest method of procedure is to isolate the essential part of the whole diagram and to match it with the given quarter. The tests require ability to recognize identities and to carry a spatial scheme in mind. The subject does not need any knowledge of words beyond that required to understand instructions. Of the arabic numerals he needs merely enough knowledge to enable him to write the identification numbers. The average correlations of this pair with the other members of the group, excluding handwriting, are only +27 (raw) and only +48 (modified), while the average reliability coefficient is +52. This test thus correlates half as well with one of the others as with itself.

Tests A11 & A12 (Diagram Drawing) require synthetic ability. The subject must be able to understand and to follow a pattern and to carry a spatial scheme in mind. A knowledge of words beyond the instructions is unnecessary. The average correlations of this pair with the other members of the group, excluding handwriting, are only +24 (raw) and only +34 (modified), while the average reliability coefficient is +80. This very large reliability coefficient is due probably to the very large average deviations, which are larger than any others in the whole investigation except tests E7 & E8, and also to the fact that both chance and practice have but little effect on the subjects' scores. This test thus correlates less than one third as closely with one of the other tests as it does with itself.

Tests A 13 & A14 (Handwriting) require a highly complex form of motor activity and coordination of the arm, of the wrist,

[1] "The Mental Differences Between the Sexes," *Journal of Experimental Pedagogy*, 1912.

of the fingers, of the eyes, and of the cerebro-spinal system. The exceeding complexity of handwriting can be perceived by right-handed persons if they will endeavor to write with the left hand. These tests require some, but not an accurate knowledge of spelling, since the subjects were not penalized for misspelled words. They require ability to transmute sounds into legible symbols, and to make these symbols clear, even, and beautiful. The average correlations of this pair with the other members of the group are —10 (raw) and —15 (modified), while the reliability coefficient is +64. This is the highest reliability coefficient in the group except A11 and A12 which is +80 and A5 and A6, which is +65. Handwriting as tested is thus nowise a symptom of the sort of ability required to assemble mechanisms, tie knots or dismember puzzles.

The low average correlations, apart from handwriting, the highest raw being +31 and the highest modified being +50, indicate that the functions involved in any one test are not identical with the functions involved in the other tests. This is especially true of the handwriting, the correlations of which indicate not only that the functions are different, but that they are somewhat incompatible.

The Spatial Relations Tests

The notes which follow are based upon Tables 3 and 4. Much more extended tests are needed before anything certain can be inferred about the community of these tests. So far as these results go it is slight. Because of the low correlations of the two halves of the Locus test one with another, and of the test for Similar Figures with the test for Congruent Figures, the modifications for attenuation are subject to very large probable errors.

Tests B1 & B2 (Rhombuses). The average correlations of this pair with the other members of the group is only +10 (raw) and only +28 (modified), while the average reliability coefficient is +58.

Tests B3 & B4 (Locus) seem to demand selective thinking with spatial relations and a knowledge of words and of some well-known objects: canal, boat, watch, circles, parallel straight

TABLE 3—SPATIAL RELATIONS TESTS

Averages of Boys' and of Girls' Average Raw Correlations

	Rhombus Tests B1&B2	Locus Tests B3&B4	Matching Similar and Congruent Figures B5&B6
B1&B2		14	05
B3&B4	14		08
B5&B6	05	08	
	19	22	13
Averages:	10	11	06
	B1&B2	B3&B4	B5&B6
Reliability Coefficients	58	22	04

TABLE 4—SPATIAL RELATIONS TESTS

Averages of Boys' and of Girls' Correlations Modified for Attenuation

	Rhombus Tests B1&B2	Locus Tests B3&B4	Matching Similar and Congruent Figures B5&B6
B1&B2		34	21
B3&B4	34		47
B5&B6	21	47	
	55	81	68
Averages:	28	40	34

lines, pencil, string, helix, scissors, curves, points of the compass, houses, roads. The average correlations of this pair with the other members of the group are only +11 (raw) and only +40 (modified), while the average reliability coefficient is only +22. This low reliability coefficient is probably due to the intrinsic difficulty of the test. With some 150 high school girls Miss Rogers obtained a reliability coefficient of only +05.

Tests B5 & B6 (Applying Definitions of Similar and of Congruent). Understanding of the definitions given for "Similar" and for "Congruent" and recognition of similarities and of differences in form are the essential requirements. The average correlations of this pair with the other members of the group are only +06 (raw) and only +34 (modified), while the average reliability coefficient is only +04.

Arithmetical Tests—Computation

Each of these eight tests requires some addition, some subtraction, some multiplication and some division, although tests C3 & C4 are primarily concerned with addition, tests C5 & C6 with subtraction, and tests C7 & C8 with division. Tests C3 to C8 are alike in that they require no ability in reading words and do measure stock arithmetical knowledge.

Tests C1 & C2 should have been put in a group by themselves or in the D group, but this was realized too late. That these tests do not belong to this C group is clearly shown by their

TABLE 5—ARITHMETICAL TESTS: COMPUTATION

Averages of Boys' and of Girls' Average Raw Correlations.

	"Catch Problems"	Addition	Subtraction	Division
	C1&C2	C3&C4	C5&C6	C7&C8
C1 & C2...	..	16	24	26
C3 & C4...	16	..	34	34
C5 & C6...	24	34	..	42
C7 & C8...	26	34	42	..
	66	84	100	102
Averages ..	22	28	33	34
Averages, excluding C1 & C2.....		34	38	38

Reliability Coefficients..... C1&C2 44

TABLE 6—ARITHMETICAL TESTS: COMPUTATION

Averages of Boys' and of Girls' Correlations Modified for Attenuation.

	"Catch Problems"	Addition	Subtraction	Division
	C1&C2	C3&C4	C5&C6	C7&C8
C1 & C2...	..	36	51	56
C3 & C4...	36	..	84	86
C5 & C6...	51	84	..	94
C7 & C8...	56	86	94	..
	143	206	229	236
Averages..	48	69	76	79
Averages, excluding C1 & C2.....		85	89	90

C3&C4 34 C5&C6 49 C7&C8 40

average correlations with the other members of the group, which are only +22 (raw) and only +48 (modified), while the average reliability coefficient is +44.

Tests C3 & C4 have average correlations of only +28 (raw) and only +69 (modified) with the other members of the group, while the reliability coefficient is only +34. If tests C1 & C2 are omitted from the group then the average correlations become +34 (raw) and +85 (modified).

Tests C5 & C6 have average correlations of only +33 (raw) and +76 (modified) with the other members of the group, while the reliability coefficient is only +49, though this is the highest reliability coefficient in the group. If tests C1 & C2 are omitted from the group then the average correlations become +38 (raw) and +89 (modified).

Tests C7 & C8 have average correlations of only +34 (raw) and +79 (modified) with the other members of the group, while the reliability coefficient is only +40. If tests C1 & C2 are omitted from the group then the average correlations become +38 (raw) and +90 (modified).

A test in Addition, Subtraction or Division thus correlates almost as closely with one of the others as it does with itself.

Arithmetical Problems: Verbally Stated

Even a cursory reading of these tests shows that their contents are very similar. This conclusion is supported by their correlations, which show that the difference between any two pairs is

about the same as the difference between any other two pairs, and this statement is true whether the raw or the modified coefficients are considered. All the average raw correlations are low, the largest is only +35; likewise all the average reliability coefficients are low, the largest is only +38. On the other hand, all the average modified correlations are very large, the smallest being +83 and their average being +98. The largest of these exceeds even unity, which condition is due to the small size of the reliability coefficients compared with the size of the cross correlations (e. g., D1 & D3, D1 & D4, D2 & D3 and D2 & D4).

TABLE 7—ARITHMETICAL PROBLEMS: VERBALLY STATED

Averages of Boys' and Girls' Average Raw Correlations

	D1&D2	D3&D4	D5&D6
D1 & D2.....	..	38	30
D3 & D4.....	38	..	32
D5 & D6.....	30	32	..
	68	70	62
Averages	34	35	31

TABLE 8—ARITHMETICAL PROBLEMS: VERBALLY STATED

Averages of Boys' and Girls' Correlations Modified for Attenuation

	D1&D2	D3&D4	D5&D6
D1 & D2.....	..	104	83
D3 & D4.....	104	..	106
D5 & D6.....	83	106	..
	187	210	189
Averages	94	105	94

Reliability Coefficients	D1&D2 38	D3&D4 30	D5&D6 34

Dr. Bonser's description of his tests (1910, p. 14) [1] may be applied to all these: "The problems in arithmetic test the mathematical judgment, in general that form of deductive reasoning most closely resembling the syllogistic movement of formal logic. The steps here involved are three: First, the analysis of the situation by which the essential features of the problem are conceived and abstracted; second, the recall of an appropriate principle to be applied to the abstracted problem, a search among various principles which may suggest themselves for the right one; and third, involved in the second, the inference, the recognition of identity between the known principle and the new situation. While this process goes on as implicit, explicitly there are made the concrete applications in the resolution of the problems. Clearly these are examples of deductive reasoning of the usual scientific type, involving data, principles, and inferences. The only element omitted is that of verification, which, by the nature of the tests, cannot here be brought out."

[1] *Loc. cit.*

Very-Verbal Tests

All these tests are based essentially upon a knowledge of words and thus differ from many of the preceding tests. The notes which follow are based upon Tables 9 and 10.

Tests E1 & E2 (Use of Grammatical Definitions) require a knowledge of grammar, the former especially of verbs and the latter especially of subject, predicate, adjective, adverb and modifiers. Ability to reason would be desirable, though the subjects in these tests probably preferred to respond under the influence of first impressions. The tests are far too short to measure the abilities concerned. The average correlations of this pair with the other members of the group are only +19 (raw) and +78

TABLE 9—VERY VERBAL TESTS

Averages of Boys' and of Girls' Average Raw Correlations

	Grammar Use of Definitions	Grammar Usage	Mixed Relations	Mixed Relations	Paragraph Reading	Directions	Word Knowledge		
	E1&E2	E3&E4	E5&E6	E7&E8	E9&E10	E11& E12	E13& E14	E15& E16	E17& E18
E1 & E2.....	..	—04	26	20	25	22	19	30	12
E3 & E4.....—04	..	16	09	—04	—03	02	12	08	
E5 & E6.....	26	16	..	57	48	41	52	66	33
E7 & E8.....	20	09	57	..	36	24	41	46	26
E9 & E10.....	25	—04	48	36	..	26	32	46	24
E11 & E12....	22	—03	41	24	26	..	26	30	14
E13 & E14....	19	02	52	41	32	26	..	53	33
E15 & E16....	30	12	66	46	46	30	53	..	34
E17 & E18....	12	08	33	26	24	14	33	34	..
	150	36	339	259	233	180	258	317	184
Average	19	04	42	32	29	22	32	40	23
	E1&E2	E3&E4	E5&E6	E7&E8	E9&E10	E11& E12	E13& E13	E15& E16	E17& E18
Reliability Coefficients ...	08	31	76	74	37	52	64	72	16

TABLE 10—VERY VERBAL TESTS

Averages of Boys' and of Girls' Correlations Modified for Attenuation

	E1&E2	E3&E4	E5&E6	E7&E8	E9&E10	E11& E12	E13& E13	E15& E16	E17& E18
E1 & E2.....	..	—10	60	48	120	73	62	80	192
E3 & E4.....—10	..	28	15	—08	—07	04	22	80	
E5 & E6.....	60	28	..	76	90	64	75	90	75
E7 & E8.....	48	15	76	..	66	40	58	62	58
E9 & E10.....	120	—08	90	66	..	57	61	86	84
E11 & E12....	73	—07	64	40	57	..	46	48	44
E13 & E14....	62	04	75	58	61	46	..	76	85
E15 & E16....	80	22	90	62	86	48	76	..	80
E17 & E18....	192	80	75	58	84	44	85	80	..
	625	124	558	423	556	365	467	544	698
Averages	78	16	70	53	70	46	58	68	87
Averages omitting E3 & E4	91	..	76	58	81	53	66	75	88

(modified), while the average reliability coefficient is only +08. The difference between the raw and the modified coefficients is due, of course, to the small size of the reliability coefficient. This is especially true when E1 & E2 and E17 & E18 are compounded by the formula (*e*), the denominator of the fraction being necessarily very small, and thereby making the value of the whole fraction very large. The low raw correlation may be due to the element of chance which enters largely into these tests and to the short space of time given for the replies.

Tests E3 & E4 (Grammatical Usage) require a knowledge of grammar, both etymological and syntactical, both of abstract rules and of concrete examples. Reasoning ability might, therefore, determine very largely the response, yet many of the pupils seem to have marked as correct those forms which they were in the habit of using or which they had often heard approved. The average correlations of this pair with the other members of the group are only +04 (raw) and only +16 (modified), while the reliability coefficient is only +31. The average raw and the average modified correlations are the lowest in this whole group, while the average reliability coefficient is much lower than all the others except two: E1 & E2 and E17 & E18. The very low raw correlation may be due to the element of chance, which enters largely into it. The lowness of both the raw and the modified correlations may be due also to the ambiguity of certain of the replies as signs of intellect. Expert teachers of English composition are not unanimous in their opinions concerning some of the forms, therefore answers which some teachers would mark correct, others would mark incorrect.

Tests E5 & E6 (Mixed Relations) have comparatively a high average correlations with the other members of the group: +42 (raw) and +70 (modified), while the reliability coefficient +76 is the highest in this group. *Tests E7 & E8* (Mixed Relations) have only moderately high average correlations with the other members of the group: +32 (raw) and +53 (modified), while the reliability coefficient +74 is next to the highest in the group. The difference between the correlations of the two pairs may be due to the fact that tests E5 & E6 were given orally and the time allowed for each quartette was the same. The tests thus given are more difficult than when given visually, as were tests

E7 & E8, and when the time for the whole, but not for each quartette, is limited. The element of chance has but little influence on this kind of tests.

Tests E9 & E10 (Paragraph Reading). The average correlations of this pair with the other members of the group are moderately high: +29 (raw) and +70 (modified), while the reliability coefficient is only +37. The element of chance enters but slightly into these tests.

Tests E11 & E12 are a test of sentence reading plus care in performing simple clerical operations. The test is very short and has a reliability coefficient of only +52 between the two trials, three months apart. It correlates with the two tests of paragraph reading about two thirds as clearly as they do one with the other. The averages of its correlations with the other tests in the group are +22 (raw) and +46 (modified).

Tests E13 & E14, E15 & E16 and *E17 & E18* are all tests of word knowledge. Tests E13 & E14 have eight rubrics, tests E15 & E16 and E17 have four rubrics, and test E18 uses the method of checking synonyms, together with that of choosing words of stated properties. The interrelations of these tests with each other and with all the others save the tests in Grammatical Usage E3 & E4 are, as shown in the tables, fairly close.

In general, Tables 9 and 10 give evidence that Word Knowledge and Paragraph Reading are clearly correlated, but that a knowledge of correct usage (if the Starch Scale tests such) is much less clearly related to them than they are to each other. A difference in the difficulty of the paragraphs to be read or in the varieties of words to be classified seems to reduce correlation measurably from unity, but the probable errors of all the coefficients are too large to make this indubitable.

Tests F1 & F2 (Faulty Arguments) and *F3 & F4* (Catches) require ability to perceive and to explain fallacies. They require a knowledge of facts, a practical though not a theoretical knowledge of the syllogism, and some subtlety of thought. These four tests are probably somewhat too difficult for pupils of the sixth grade. Moreover, they would be better if more questions were added, thus having four times as many tests, or if each paper were four times as long. The average correlations between the two

Logical Tests

TABLE 11—LOGICAL TESTS

Averages of Boys' and of Girls' Average Raw Correlations

	Faulty Arguments F1&F2	Catches F3&F4
F1 & F2		26
F3 & F4	26	
	26	26
Averages	26	26
	F1&F2	F3&F4
Reliability Coefficients	31	16

TABLE 12—LOGICAL TESTS

Averages of Boys' and of Girls' Correlations modified for Attenuation

	Faulty Arguments F1&F2	Catches F3&F4
		90
	90	
	90	90
	90	90

pairs are +26 (raw) and +90 (modified), while the average reliability coefficient of tests F1 & F2 is +31 and of tests F3 & F4 +16. The low reliability coefficients accounts for the large difference between the raw and the modified coefficients.

SECTION III

THE COMPOSITE ABILITIES AND THEIR INTERRELATIONS

All the #A Tests (Manipulative), except A13 & A14, were combined into two composite scores for each individual by multiplying his deviation from the average for his sex in A1 & A2 by 2, his deviation from the average of his sex in A3 & A4 by 6, and so on as shown in the table of weights below (Table 13). The A1, A3, A5, A7, A9, A11 products were added to form #A1. The A2, A4, A6, A8, A10, A12 products were added to form #A2, #B1 and #B2, two composite scores for each individual in all the B Tests (Spatial Relations) were formed similarly. Similarly for #C1 and #C2, #D1 and #D2, #E1 and #E and #F1 and #F2.

It will be seen in the table that all the tests within any one group are given about equal weight, with the following excep-

TABLE 13—AVERAGE DEVIATION OF THE SEPARATE TESTS

	Boys		Girls		Total	Multiplier used in obtaining Composite Scores	Approximate Weight Attached	
A1 &A2	8.06	7.72	6.31	5.84	27.93	2	56	
A3 &A4	2.62	1.97	1.89	1.16	7.64	6	46	
A5 &A6	3.22	4.20	3.66	5.41	16.49	3	50	
A7 &A8	6.53	5.08	5.02	5.12	21.75	2	44	
A9 &A10	2.72	3.88	2.88	3.88	13.36	4	53	
A11&A12	8.77	7.06	6.51	8.54	30.88	2	62	
A13&A14	12.14	12.70	10.47	10.40	45.71			
B1 &B2	5.95	5.92	3.45	5.75	21.07	1	21	
B3 &B4	1.62	1.27	.75	1.23	4.87	4	19	
B5 &B6	3.00	1.91	3.53	2.10	10.54	2	21	
C1 &C2	1.09	1.00	.88	.76	3.73	2	8	
C3 &C4	2.25	2.22	2.31	2.16	8.94	1	9	
C5 &C6	2.34	2.59	1.98	2.67	9.58	1	10	
C7 &C8	2.65	2.39	2.39	2.22	9.65	1	10	
D1 &D2	.97	.80	1.20	1.05	4.02	1	4	
D3 &D4	.97	.88	1.05	.95	3.85	1	4	
D5 &D6	1.19	.89	1.13	.80	4.01	1	4	
E1 &E2	1.36	1.43	1.19	1.51	5.49	3	16	
E3 &E4	3.52	2.23	3.51	3.21	12.47	3	37	
E5 &E6	5.97	5.32	5.71	5.14	22.14	1	22	
E7 &E8	7.19	9.73	7.62	8.69	33.23	1	33	55
E9 &E10	3.14	4.08	3.07	5.02	15.31	3	45	
E11&E12	2.57	2.12	2.22	1.66	8.57	1	9	54
E13&E14	3.38	3.22	3.43	3.28	13.31	1	13	
E15&E16	8.00	5.31	8.04	4.98	26.33	1	26	64
E17	6.26		9.71		15.97	1	16	
&E18		2.26		2.09	4.35	2	9	
F1 &F2	.59	.63	1.00	.86	3.08	1	3	
F3 &F4	1.36	.81	1.35	.75	4.27	1	4	

tions: Handwriting is given no weight at all. E1 & E2 (Understanding and Use of Grammatical Definitions) are given about one quarter as much weight as E5 & E6 and E7 & E8 (Mixed Relations), E9 & E10 (Paragraph Reading) or E13 & E14, E15 & E16 and E17 & E18 (Word Knowledge), and half as much weight as the tests E3 & E4 (Usage).

On the basis of present knowledge these weightings could be improved, as by the separation of C1 & C2 or by their transfer to the D group, and by attaching much less weight to E3 & E4.

The correlations of the two composites of the same group were as follows:

TABLE 14—RELIABILITY COEFFICIENTS OF THE COMPOSITE SCORES

	31 Boys	38 Girls	Average
#A1 & #A2	90	77	84
#B1 & #B2	55	17	~~36~~ 36
#C1 & #C2	70	69	70
#D1 & #D2	56	70	63
#E1 & #E2	82	80	81
#F1 & #F2	39	25	32

TABLE 15—AVERAGE RAW CORRELATIONS OF THE COMPOSITES

Boys	#A	#B	#C	#D	#E	#F	Girls	#A	#B	#C	#D	#E	#F
#A		60	24	00	30	—07			15	29	14	31	08
#B	60		12	03	18	08		15		07	18	21	29
#C	24	12		51	31	—25		29	07		60	47	10
#D	00	03	51		22	—13		14	18	60		59	26
#E	30	18	31	22		32		31	21	47	59		42
#F	—07	08	—25	—13	32			08	29	10	26	42	

TABLE 16—CORRELATION OF THE COMPOSITES MODIFIED FOR ATTENUATION

Boys	#A	#B	#C	#D	#E	#F	Girls	#A	#B	#C	#D	#E	#F
#A		86	29	01	34	—11			30	29	19	39	10
#B	86		18	05	25	16		30		14	50	46	128
#C	29	18		80	41	—41		29	14		86	61	21
#D	01	05	80		31	—24		19	50	86		79	57
#E	34	25	41	31		49		39	46	61	79		92
#F	—11	16	—41	—24	49			10	128	21	57	92	

TABLE 17—AVERAGES OF THE BOYS' AND OF THE GIRLS' CORRELATIONS MODIFIED FOR ATTENUATION

	#A	#B	#C	#D	#E	#F
#A		58	29	10	37	00
#B	58		16	28	36	72
#C	29	16		83	51	—10
#D	10	28	83		55	17
#E	37	36	51	55		71
#F	00	72	—10	17	71	

When the Composite Scores are correlated, it appears that #C Arithmetical Computation and #D Arithmetical Problems, stated in words, are most akin; The Very-Verbal #E and the Logical #F tests are closely allied; the so-called Manipulative #A group and the Spatial Relations #B group are next most closely

allied. Between the Manipulative #A group and the Logical #F group the correlation appears to be very low. The facts are given in Tables 15 and 16. The differences between the results for boys and those for girls show regrettably great unreliability which attaches to even these results from the Composites. If we assume that the Boy-Girl division of the material is a random division, we have as a result of all the errors that have accumulated in correlating and modifying for attenuation, unreliabilities attached to the final section of Table 17 as follows:

TABLE 18

	#A		#B		#C		#D		#E	
	r	P.E.	*r*	P.E.	*r*	P.E.	*r*	P.E.	*r*	P.E.
#B	58	14								
#C	29	00*	16	01						
#D	10	045	28	11	83	015				
#E	37	01	36	05	51	05	55	12		
#F	00	05	72	28	—10	155	17	20	71	11

*This technical zero is not, of course, to be taken at its face value.

If we leave out the Spatial Relations #B and Logic #F Composites, which have low coefficients of self-correlation, we have:

TABLE 19

	#A		#C		#D	
	r	P.E.	*r*	P.E.	*r*	P.E.
#C	29	small				
#D	10	045	83	015		
#E	37	01	51	05	55	12

These results are sound enough, perhaps, to justify the assertions (1) that the Mechanical and Diagram test ability is much less closely related to ability with numbers or ability with words than these are one with another; (2) that Arithmetical Problems of the sort used for the pupils in grade six are only slightly contaminated by differences in ability to read words (55 *vs.* 51), (3) that such problems are a very unsafe test of general ability to reason, and (4) that the Verbal Composite is the best single representative of the whole set of Composites.

SECTION IV

THE HIERARCHY OF THE SPECIFIC INTELLIGENCES

The writer had not the slightest intention of employing the data of this study as a criterion of Spearman's theory of intelligence until all the coefficients of correlation had been obtained. Then, perceiving that the material was well suited for such a study, he calculated the correlations of the correlational columns for the six Composites. He was wholly unbiased; he cared nothing whether the unifocal theory was supported or discredited. Either result would have been equally satisfactory to him.

Dr. Spearman writes (1904, p. 225): "We must insist upon a precise quantitative expression derived impartially from the entire available data; we must renounce adroit manipulation of tables and graphs, still further rounded into the required shape by ingenious argument; the whole of our experimentally gained figures must without any selective treatment simply of themselves issue into one plain numerical value." The correlations used here correspond in every way to these requirements.

The correlations of the correlations for the Composites go dead against the theory of a single factor as the explanation of the amounts of resemblance found amongst the six Composites abilities, whether the raw or the modified coefficients, the coefficients for one sex separately or the averages of the corresponding coefficients for the two sexes, the most reliable or the less reliable columns are taken, the average correlation of the correlations is far below unity, being in general much nearer zero than unity.

The data, underlying a study of the theory of the hierarchy, may be manipulated in various ways and the results obtained depend upon the method of manipulation which has been employed.

First Method: All the correlational columns of the raw composites have been correlated and the results have been tabulated and are given in Tables 20 and 21. In this method no manipulation of any kind whatsoever has been practised. Every correlation, without any regard to the size of the coefficient, has been allowed full weight. The boys show 66 correlations, the total of the positive correlations being 1,458, the total of the negative

TABLE 20—BOYS

RAW CORRELATIONS OF THE COMPOSITE CORRELATIONAL COLUMNS

	Manipulative		Spatial		Non-Verbal Arithmetic		Verbal Arithmetic		Very-Verbal		Logical	
	#A1	#A2	#B1	#B2	#C1	#C2	#D1	#D2	#E1	#E2	#F1	#F2
#A1.....	..	97	95	90	—03	14	—11	—23	—01	04	—01	01
#A2.....	97	..	89	87	10	14	—10	—18	—07	—02	—07	—16
#B1.....	95	89	..	94	—11	—04	—26	—56	—07	—09	09	—08
#B2.....	90	87	94	..	—15	—03	—40	—47	—08	—15	03	—19
#C1.....	—03	10	—11	—15	..	91	91	83	—03	—02	—66	—69
#C2.....	14	14	—04	—03	91	..	77	82	—03	06	—58	—70
#D1.....	—11	—10	—26	—40	91	77	..	91	21	—02	—56	—49
#D2.....	—23	—18	—56	—47	83	82	91	..	01	05	—56	—52
#E1.....	—01	—07	—07	—08	—03	—03	21	01	..	58	45	33
#E2.....	04	—02	—09	—15	—02	06	—02	05	58	..	31	60
#F1.....	—01	—07	09	03	—66	—58	—56	—56	45	31	..	76
#F2.....	01	—16	—08	—19	—69	—70	—49	—52	33	60	76	..
	301	297	287	274	275	284	280	262	158	164	164	170
	—39	—60	—121	—147	—169	—138	—194	—252	—29	—30	—244	—283

TABLE 21—GIRLS

#A1.....	..	23	—15	03	10	02	—12	—24	—02	—12	—22	—17
#A2.....	23	..	—74	06	39	30	14	02	15	04	—16	—50
#B1.....	—15	—74	..	##39	—37	—44	—20	—09	30	—11	38	50
#B2.....	03	06	39	..	—21	—43	03	—16	43	05	43	56
#C1.....	10	39	—37	—21	..	98	84	81	60	72	34	—26
#C2.....	02	30	—44	—43	98	..	80	79	52	69	10	—20
#D1.....	—12	14	—20	03	84	80	..	95	66	85	65	02
#D2.....	—24	02	—09	—16	81	79	95	..	68	84	44	10
#E1.....	—02	15	30	43	60	52	66	68	..	77	51	26
#E2.....	—12	04	—11	05	72	69	85	84	77	..	45	21
#F1.....	—22	—16	38	43	34	10	65	44	51	45	..	50
#F2.....	—17	—50	50	56	—26	—20	02	10	26	21	50	..
	38	133	157	198	478	420	494	463	488	462	380	215
	—104	140	210	80	84	107	32	49	2	23	38	113
	—66	—7	—53	118	394	313	462	414	486	439	342	102

correlations being 853, and the average being +09. The girls show 66 correlations, the total of the positive correlations being 1,963, the total of the negative correlations being 491, and the average being +22. The average for both sexes, +16, gives no evidence for the theory of the common factor.

Second Method: The manipulation employed in this method is the combining of the correlations from #A1 and #A2, those from #B1 and #B2, etc., and the using of their averages. The results are given in Table 22. The boys show 15 correlations, the total of the positive correlations being 299, the total of the negative correlations being 286 and the average being +01. The girls show 15 correlations, the total of the positive correlations being 509, the total of the negative correlations being 169 and the average being +23. The average for both sexes, +12, is as before against the theory of the Common Factor.

TABLE 22—CORRELATIONS OF THE CORRELATIONS. FORMULA (1)

	BOYS							GIRLS					
Boys	#A	#B	#C	#D	#E	#F	Girls	#A	#B	#C	#D	#E	#F
#A		86	12	20	—59	41			—64	46	91	09	04
#B	86		06	—27	29	03		—64		—60	—38	—04	78
#C	12	06		85	—53	—33		46	—60		73	81	21
#D	20	—27	85		17	—14		91	—38	73		76	30
#E	—59	29	—53	17		—73		09	—04	81	76		—03
#F	41	03	—33	—41	—73			04	78	21	30	—03	

TABLE 23—CORRECTED BY DR. SPEARMAN'S FORMULA (1)

	#A	#B	#C	#D	#E	#F		#A	#B	#C	#D	#E	#F
#A			09	30									
#B			04										
#C	09	04											
#D	30												
#E													
#F	68												

TABLE 24—ARITHMETIC COMBINED RAW. FORMULA (2)

	#A	#B	#CD	#E	#F		#A	#B	#CD	#E	#F
#A		86	62	—99	37			—56	91	49	65
#B	86		39	16	—11		—56		—18	—19	82
#CD	62	39		—50	82		91	—18		55	77
#E	—99	16	—50		—73		49	—19	55		—34
#F	37	—11	82	—73			65	82	77	—34	

Third Method: The manipulation employed in this method is the same as that of the second method, only it proceeds farther and averages the correlations for the two Arithmetical Composites: C and D. The boys show 10 correlations with an average of +09. The girls show 10 correlations with an average of +29, giving an average of +19 for the two sexes together. It will be observed that the elimination of the correlations between two identical or closely similar abilities does not raise the correlations of the columns toward the high values required by the theory of a common factor. Table 24.

Fourth Method: Dr. Spearman lays down the standard (1912, p. 56): "In order to attempt to estimate the correct correlation between the columns, it is required that in each of these columns the mean square deviation should be at least double the correction to be applied to that deviation." And again he writes (1914, p. 112): "Reject all pairs of columns, in either of which the sum of the squares of the probable errors exceeds one-fourth of the sum of the deviations from the average." This fourth method is in harmony with the above standard, otherwise it is the same as the first method. The columns and their correlations which remain are:

TABLE 25

Boys				Girls			
	r		*r*		*r*		*r*
#A1 & #A2	97	#B2 & #C1	—15	#A1 & #C1	10	#C1 & #D1	84
#A1 & #C1	—03	#B2 & #C2	—03	#A1 & #C2	02	#C1 & #~~C2~~	81
#A1 & #C2	14	#B2 & #D1	—40	#A1 & #D1	—12	#C1 & #E1	60
#A1 & #D1	—11	#B2 & #D2	—47	#A1 & #D2	—24	#C1 & #E2	72
#A1 & #D2	—23	#B2 & #F1	03	#A1 & #E1	—02	#C2 & #D1	80
#A1 & #F1	—01	#C1 & #C2	91	#A1 & #E2	—12	#C2 & #D2	79
#A2 & #C1	10	#C1 & #D1	91	#A2 & #C1	39	#C2 & #E1	52
#A2 & #C2	14	#C1 & #F1	—66	#A2 & #C2	30	#C2 & #E2	69
#A2 & #D1	—10	#C2 & #D1	77	#A2 & #D1	14	#D1 & #D2	95
#A2 & #D2	—18	#C2 & #D2	82	#A2 & #D2	02	#D1 & #E1	66
#A2 & #F1	—07	#D1 & #F1	—56	#A2 & #E1	15	#D1 & #E2	85
#B1 & #C1	—11	#D2 & #F1	—56	#A2 & #E2	04	#D2 & #E1	68
#B1 & #C2	—04			#C1 & #C2	98	#D2 & #E2	~~81~~ 84

The Probable Errors for the single correlations of the Composites are as follows:

TABLE 26

Formula (*g*)			Formula (*h*)			
	31 Boys	38 Girls		31 Boys	38 Girls	
r	P.E.	P.E.	*r*	P.E.	P.E.	
10	12	11	0 to 22	12	0 to 20	11
20	12	11	23 to 36	11	21 to 36	10
30	11	10	37 to 46	10	37 to 47	9
40	10	9	47 to 54	9	48 to 56	8
50	9	8	55 to 61	8	57 to 63	7
55	8	8	62 to 68	7	64 to 70	6
60	8	7	69 to 73	6	71 to 76	5
65	7	6	74 to 79	5	77 to 82	4
70	6	6	80 to 84	4	83 to 86	3
75	5	5	85 to 89	3	87 to 92	2
80	4	4	90 to 93	2	93 to 97	1
85	3	3	94 to 97	1	98 to 100	0
90	2	2	98 to 100	0		
95	1	1				
100	0	0				

The boys show 25 correlations, the total of the positive correlations being 479, the total of the negative correlations being 371, and the average being +04. The girls show 26 correlations, the total of the positive correlations being 1,189, the total of the negative correlations being 50, and the average being +44. The combined result is +24.

Fifth Method: This is the same as the second method, except that the standard mentioned in the fourth method is employed. For the boys three columns and their correlations remain, the other twelve being excluded by the standard. These three are: #A & #C+12, #A & #D+20, #B & #C+06. The average is +13. For the girls all the columns are excluded by the standard.

Sixth Method: This is the same as the third method, except that the standard mentioned in the fourth method is employed. By this method all the columns for both boys and girls are excluded by the standard.

Seventh Method: This is the same as the first method, except

that both the standard and the formula (j) are applied. The columns and their correlations, which remain, are:

TABLE 27

Boys						Girls					
#A1 & #A2	102	#B2 & #C1	—19	#A1 & #C1	13	#C1 & #D1	96				
#A1 & #C1	00	#B2 & #C2	00	#A1 & #C2	00	#C1 & #D2	93				
#A1 & #C2	14	#B2 & #D1	—59	#A1 & #D1	—19	#C1 & #E1	78				
#A1 & #D1	—13	#B2 & #D2	—78	#A1 & #D2	—41	#C1 & #E2	84				
#A1 & #D2	—32	#B2 & #F1	11	#A1 & #E1	00	#C2 & #D1	85				
#A1 & #F1	—01	#C1 & #C2	104	#A1 & #E2	—05	#C2 & #D2	86				
#A2 & #C1	07	#C1 & #D1	106	#A2 & #C1	41	#C2 & #E1	57				
#A2 & #C2	07	#C1 & #F1	—85	#A2 & #C2	21	#C2 & #E2	74				
#A2 & #D1	—10	#C2 & #D1	89	#A2 & #D1	08	#D1 & #D2	109				
#A2 & #D2	—24	#C2 & #D2	113	#A2 & #D2	00	#D1 & #E1	75				
#A2 & #F1	—10	#D1 & #F1	—77	#A2 & #E2	00	#D1 & #E2	97				
#B1 & #C1	—12	#D2 & #F1	—88	#A2 & #E1	03	#D2 & #E1	81				
#B1 & #C2	00			#C1 & #C2	112	#D2 & #E2	95				

Twenty-five correlations remain for the boys. The total of the positive correlations is 553, the total of the negative correlations is 508, and the average is +02. Twenty-six correlations remain for the girls. The total of the positive correlations is 1,308, the total of the negative correlations being 65 and the average being +48. The combined result, +25, is far from the approach to 100 required by the theory of the hierarchy, due to one common factor as the main cause of correlation.

Eighth Method: This is the same as the second method, except that both the standard and the formula (j) have been applied. For the boys three columns and their correlations remain: #A & #C+09, #A & #D+30, #B & #C+04. The total is +43, and the average is +11. For the girls all the columns are excluded. The evidence for the boys is against the hierarchy, and for the girls it is non-existent (Table 23).

Ninth Method: This is the same as the third method, except that both the standard and the formula (j) are employed. All the columns for both the boys and the girls are excluded.

Tenth Method: The manipulation employed in this method was the arranging in columns of the average raw correlations of boys and of girls for each Composite (Table 28), and then correlating these columns. The results are given in Table 29.

TABLE 28

Average Raw Correlations of the Boys' and of the Girls' Composites

	#A	#B	#C	#D	#E	#F
#A		38	26	07	30	00
#B	38		10	10	20	18
#C	26	10		56	39	—08
#D	07	10	46		40	07
#E	30	20	39	40		37
#F	00	18	—08	07	37	

TABLE 29

Correlations of the columns of the Average Raw Correlations of the Boys' and of the Girls' Composites

	#A	#B	#C	#D	#E	#F
#A		07	08	32	—73	36
#B	07		—26	—70	—99	04
#C	08	—26		73	35	—02
#D	32	—70	73		54	—08
#E	—73	—99	35	54		—71
#F	36	04	—02	—08	—71	

These correlations extend quite evenly from +73 to —99. Table ~~30~~ 29 shows 15 correlations, the total of the positive correlations being 249, the total of the negative correlations being 349, and the average being —07.

Eleventh Method: The manipulation used in this method was the arranging in columns of the average modified correlations of the boys and of the girls for each Composite (Table 30), and then correlating these columns; the results are given in Table 31. The correlations extend quite evenly from +68 to —97. Table 31 shows 15 correlations, the total of the positive correlations being +196, the total of the negative correlations being —467, and the average being —18.

Twelfth Method: The writer applied to Table 28 the standard and the formula (*j*), but these excluded all the columns and their correlations.

TABLE 30

Average Modified Correlations of the Boys' and of the Girls' Composites

	#A	#B	#C	#D	#E	#F
#A		58	29	10	36	00
#B	58		16	28	36	72
#C	29	16		83	51	—10
#D	10	28	83		55	16
#E	36	36	51	55		70
#F	00	72	—10	16	70	

TABLE 31

Correlations of the columns of the Average Modified Correlations of the Boys' and of the Girls' Composites

	#A	#B	#C	#D	#E	#F
#A		—66	—01	19	—93	68
#B	—66		—97	—95	24	10
#C	—01	—97		68	—17	—31
#D	19	—~~88~~ 95	68		07	—18
#E	—93	24	—17	07		—47
#F	68	10	—31	—18	—47	

It should be noted that the combination of the results reducing the sampling errors does not cause a closer approach to the +100 required by the unifocal theory; nor does the use of correlations modified to offset the effect of the chance inaccuracies in the original measures.

The correlations of the correlations for this group show no evidence of the unifocal theory, but on the contrary reveal a notable specificness in the abilities measured by the #A, #B, #C, #D, #E and #F groups. The question needs retesting with larger groups to reduce the sampling errors and with more extended tests to reduce the complexities of inference due to the low self-correlation coefficients. Spearman's use of the correlations of the correlations as a criterion of the nature of the organization of human faculty is most ingenious and important, but the actual working of his "standard" seems to cut out the columns with the low correlations and so the cases where specificness would be especially shown.

SECTION V

SEX DIFFERENCES

These tests give results supporting the conclusion of recent years that the abilities of boys and of girls of like age are on the whole approximately equal, that the boys are better in dealing with mechanical contrivances and a little better in mathematics, while the girls are better in dealing with words and verbal relations. The results may be stated most briefly in terms of percentages of overlapping or in terms of the multiple of the variability for the score in question by which the boys' average surpasses that of the girls. In this study the latter method has been chosen. With the results from the present investigation are recorded also the results from similar tests by Mrs. Woolley (H. B. Thompson), Thorndike, Rusk, Bonser, and Burt and Moore. These are shown in Tables 32 to 37.

TABLE 32

	Boys Exceed Girls by	Boys' Average — Girls' Average	Formulae (a) P.E.	Formulae (b) A.D.	Boys' Average — Girls' Average A.D.	Number of Separate Tests, in Which One Sex Exceeds the Other: Boys	Girls	Total
#A (Odds).....	2.90	2.65	.18	4.92	.50	9	3	12
#A (Evens).....	2.39							
#B (Odds).....	~~1.21~~ 1.81	1.37	~~.11~~ .20	3.04	.45	~~4~~ 5	2 1	6
#B (Evens).....	~~1.53~~ .93							
#C (Odds).....	—.19	—.26	.05	1.99	—.13	3 5	5 3 1	8
#C (Evens).....	—.34							
#D (Odds).....	.41	.35	.05	.99	.35	6	0	6
#D (Evens).....	.28							
#E (Odds).....	1.14	1.11	.03	4.37	.25	12	6	18
#E (Evens).....	1.07							
#F (Odds).....	—.26	—.18	.06	.92	—.20	0	4	4
#F (Evens).....	—.09							
Handwriting ...	—9.20	—10.54	.94	11.43	—.92	0	2	2
	—11.87					34	22	56
Puzzles A7&A8..	5.16							
	—3.14	1.01	2.93	5.44	.19	..	..	..
Analogies E5 to E8.....	.54							
	1.40	.97	.30	6.92	.14	..	..	..

TABLE 33

Computed from Mrs. Woolley's data (1903, 109, 125) 50 students.

Boys' Median — Girls' Median	Ingenuity Tests #1	#2	#3	#4	#5	Physics	Average
A.D.	—.13	+.32	+.62	+.60	+.73	+.89	+.50

TABLE 34

Computed from Thorndike's data (Ed. Psych., Vol. III, 1914, page 183).

Boys' Median — Girls' Median A.D.	Associative and Conceptual Processes	High School Mathematics	College Mathematics
	—.06	.22	—.17

TABLE 35

Computed from Miss Rusk's data (Thorndike, Ed. Psych., Vol. III, p. 184).

Boys' Median — Girls' Median A.D.	High School English	High School Physics
	—.55	.35

TABLE 36

Computed from Dr. Bonser's data (1910).
(Grades 4A to 6A)

	Boys' Median — Girls' Median	Average	P.E.	A.D.	Boys' Median — Girls' Median A.D.
Mathematical	3.14				
Judgment	5.73				
Table VI	3.83	3.27	± .44	6.21	.53
Page 25	1.55				
	2.08				
Controlled	—.15				
Association	.39				
Table XIII	.18	.29	± .08	3.43	.08
Page 35	.71				
	.30				
Controlled	—12.16				
Association	—3.50				
Table XX	—5.25	—5.35	± 1.08	15.10	—.35
Page 42	—4.58				
	—1.25				
Selective	.51				
Judgment	1.90				
Table XXVI	—4.25	.20	± .83	9.90	.02
Page 52	4.00				
	—1.16				

TABLE 37

Computed from Burt and Moore's data (1912, pp. 372-375).

	Boys' Median — Girls' Median	Boys' Median — Girls' Median
65 Liverpool Children:		
Addition	15	.49
Multiplication	13	.41
130 Wallsey School Children:		
Wire Puzzles	22	.74
Reconstructing Picture Blocks	28	.92
Reconstructing Picture Postcards	—02	—.07
Analogies	—15	—.48
Completion of Arguments	07	.21

The average ages of the boys and of the girls are almost identical.

TABLE 38

	Subjects in the Composites		All the Subjects	
	31 Boys	38 Girls	37 Boys	46 Girls
Totals:	364. years	450. years	434. years	542. years
Averages:	11.741 years	11.842 years	11.73 years	11.782 years

The average marks of the two sexes obtained in the class-room examinations during February, March, April, May, and June in arithmetic, geography, history, grammar, composition, and spelling are almost identical: Boys' average marks, 79.874 marks; and girls' average marks, 79.528 marks. Therefore no appreciable difference exists between these two groups so far as ages and scholastic attainments, as measured by class-room examinations, are concerned.

If the average (see Sex Difference, Tables 33 to 38) be taken of excesses in the Manipulative Tests (#A), in Mrs. Woolley's Ingenuity Tests and Physics, in Miss Rusk's Physics and in Burt and Moore's Puzzles (wire, block, and postcard), it is +.50; that is, the boys exceed the girls by 50 per cent of one A.D.

If the average be taken of excesses in the Mathematical Tests (#B and #C and #D), in Thorndike's high school subjects, in Bonser's Table VI, and in Burt and Moore's Addition and Multiplication, it is +.27; that is, the boys exceed the girls by 27 per cent of one A.D.

If the average be taken of excesses in the Reasoning Tests (#D and #F) in Bonser's Tables VI and XXVI, and in Burt and Moore's Completion of Arguments, it is +.18; that is, the boys exceed the girls by 18 per cent of one A.D.

If the average be taken of excesses in the English Tests (#E) and Miss Rusk's High School English, it is —.15; that is, the girls exceed the boys by 15 per cent of one A.D.

If the average be taken of excesses in the Analogies E5 to E8, Thorndike's Associative and Conceptual Processes, Bonser's Controlled Association (Tables XIII and XX), and Burt and Moore's Analogies, it is —.13; that is, the girls exceed the boys by 13 per cent of one A.D.

If the average be taken of excesses in the simple Arithmetic (#C) and in Burt and Moore's Addition and Multiplication, it is +.26; that is, the boys exceed the girls by 26 per cent of one A.D.

If the average be taken of excesses in the Puzzle Tests A7 & A8 and in Burt and Moore's Puzzles (wire, blocks, and postcards), and in Mrs. Woolley's Ingenuity Tests I, III, and IV, it is +.41; that is, the boys exceed the girls by 41 per cent of one A.D.

In the handwriting the girls exceed the boys by 92 per cent of one A.D.

In the Separate tests of this study (Table 32) the boys are superior in ~~34~~ 35 tests and the girls in ~~22~~ 21 tests out of 56.

In the Composites the boys are superior in (#A1), (#A2), (#B1), (#B2), (#D1), (#D2), (#E1) and (#E2), while the girls are superior in (#C1), (#C2), (#F1) and (#F2).

Sex Variability

The variability of the boys is, on the whole, a trifle greater than that of the girls. The respective average deviations in the Composites are as follows:

TABLE 39

AVERAGE DEVIATIONS (WEIGHTED) OF THE COMPOSITES

	#A1	#B1	#C1	#D1	#E1	#F1	#A2	#B2	#C2	#D2	#E2	#F2
Boys	56.5	12.0	7.41	2.32	33.3	1.67	53.2	10.4	6.93	1.87	31.8	1.35
Girls	39.1	8.8	5.73	2.47	41.6	1.92	47.1	9.7	6.42	2.07	33.6	1.26

SECTION VI

INDIVIDUAL AND COMPOSITE SCORES

Appended in Tables 40 and 41 are the original gross scores for each individual in each test and in Tables 42 and 43 are the Composite Scores devised by adding the weighted deviations as described on page 49.

Appended in Table 44 are the averages for each sex in each test, and in Tables 45 to 48 the Reliability Coefficients or Correlations between the two trials of the same test, or two similar tests, and in Tables 49 to 56 the raw Correlations of each with every other test in its group, and in Tables 57 to 62 the correlations, modified by Spearman's formulae (e and f) for A1 & A2 with A3 & A4, A1 & A2 with A5 & A6, and so on, and in Tables 63 and 64 the raw correlations of the Composite Scores, and in Table 65 the modified Correlations of the Composites.

TABLE 40—BOYS' SCORES

Boy	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	B1	B2	B3	B4
1	20	2	5	4	8	11	25	15	—	—	—	—	194	213	6	0	1	0
2	24	30	3	4	19	20	20	23	20	20	29	30	207	202	12	4	3	3
3	11	6	12	14	3	12	27	6	17	20	30	30	218	210	4	6	5	6
4	37	23	8	4	6	4	26	15	—	—	—	—	185	195	13	13	6	7
5	6	3	5	1	5	1	8	7	11	14	1	—	206	228	5	7	5	0
6	33	43	12	5	10	13	33	15	16	20	30	29	194	197	23	31	4	4
7	6	22	8	3	3	11	28	23	18	18	6	21	241	246	3	5	2	2
8	18	12	7	3	2	3	28	22	17	20	5	11	248	231	10	14	0	2
9	23	20	5	3	1	6	21	15	14	18	9	13	217	241	0	2	4	2
10	21	12	3	3	8	5	37	18	17	20	21	27	205	205	0	2	2	2
11	6	5	0	4	1	3	23	20	13	12	14	26	221	231	4	8	3	2
12	3	2	1	2	2	1	22	4	6	11	1	10	217	228	0	7	2	2
13	23	10	3	3	9	10	17	16	17	20	1	2	211	198	4	6	3	2
14	6	0	12	8	10	16	32	39	20	20	30	—	191	206	12	17	4	4
15	8	12	4	2	2	5	26	6	10	14	6	20	204	217	0	4	0	0
16	22	31	7	3	—	8	29	18	19	20	25	24	230	212	13	17	6	2
17	19	16	6	5	8	11	29	23	15	20	25	29	236	221	10	15	6	4
18	—	—	9	9	7	11	—	17	—	5	18	26	187	198	12	14	6	6
19	11	8	1	0	0	3	12	9	13	—	—	—	218	210	13	10	2	2
20	34	19	4	5	11	7	26	17	—	—	—	—	189	184	12	15	4	0
21	17	20	4	3	4	5	34	18	20	15	2	11	210	207	0	14	4	2
22	23	10	4	3	6	16	27	23	18	20	25	27	218	214	20	13	4	0
23	30	23	9	8	12	6	44	17	16	20	10	17	220	204	15	6	1	4
24	21	10	2	3	7	11	37	18	16	17	14	30	207	206	23	24	2	2
25	27	24	4	3	9	10	38	23	15	12	12	24	198	205	13	21	4	2
26	9	10	4	2	2	4	35	18	18	20	15	29	232	228	13	3	4	1
27	16	20	6	7	6	7	35	18	19	20	—	16	207	190	18	15	2	2
28	9	17	2	4	13	—	34	18	—	—	—	4	209	206	0	0	0	0
29	19	9	2	2	2	6	23	6	16	11	18	25	183	188	0	11	0	0
30	39	34	10	8	5	11	53	30	20	12	7	22	188	204	14	9	6	6
31	11	8	2	1	9	12	28	6	16	20	10	30	214	233	30	25	0	4
32	19	20	2	3	9	20	39	15	19	20	27	28	201	222	14	10	3	2
33	3	13	7	1	2	3	23	18	13	9	2	4	201	193	0	13	0	0
34	19	16	3	8	4	19	34	6	16	20	25	30	188	189	12	6	4	4
35	9	26	7	3	5	7	—	17	7	10	2	18	211	216	10	12	2	2
36	13	14	6	6	4	7	—	20	16	18	17	30	206	222	10	19	4	2
37	3	12	1	3	4	8	27	24	7	6	3	24	208	191	6	0	5	2
	618	562	190	153	218	313	980	623	495	522	440	667	7720	7791	354	398	113	87

TABLE 40 (Continued).—BOYS' SCORES

Boy	B5	B6	C1	C2	C3	C4	C5	C6	C7	C8	D1	D2	D3	D4	D5	D6	E1
1	0	16	5	5	32	33	24	33	25	31	5	2	6	4	4	4	12
2	10	16	5	5	32	31	24	33	27	32	5	3	5	4	4	4	11
3	16	14	4	4	33	35	31	29	28	30	5	3	5	3	1	5	12
4	10	13	5	5	28	29	27	31	26	28	5	3	4	4	4	2	9
5	15	14	4	4	33	32	31	28	32	25	4	2	4	1	4	4	7
6	13	15	3	2	35	34	30	32	26	31	4	2	5	4	2	3	10
7	0	12	4	2	35	34	25	27	32	28	3	4	5	4	4	5	10
8	16	16	5	5	37	29	32	26	25	31	4	5	6	5	4	5	11
9	12	9	4	4	35	36	34	30	32	29	5	5	6	5	5	5	7
10	13	12	3	3	23	35	35	33	34	33	4	5	6	5	2	5	6
11	12	14	3	4	35	28	31	31	34	30	5	5	6	5	5	5	8
12	14	14	3	3	32	29	20	22	28	24	5	5	5	5	3	5	11
13	14	13	3	5	33	35	29	31	21	27	4	4	4	4	2	2	12
14	14	15	3	3	35	27	25	26	27	27	5	3	5	5	3	4	10
15	13	10	3	4	36	30	29	23	26	28	1	1	3	3	3	5	9
16	15	14	4	3	37	33	31	27	30	32	4	4	5	5	3	5	7
17	13	16	1	4	35	32	30	32	31	29	3	3	5	3	4	4	8
18	13	9	1	3	37	31	33	27	34	28	4	3	5	5	3	5	10
19	13	10	1	4	35	32	30	32	28	31	5	4	5	5	4	5	12
20	16	14	0	3	33	29	33	29	21	25	5	2	5	5	3	4	10
21	13	7	3	3	32	32	33	22	27	22	5	2	5	5	3	5	10
22	18	14	5	3	30	29	26	31	27	27	5	2	5	5	2	5	10
23	8	11	2	3	35	30	31	29	28	27	5	3	4	5	4	4	11
24	14	16	5	3	34	29	33	31	33	32	4	3	5	5	3	5	8
25	12	16	4	2	30	38	29	29	29	29	5	4	6	5	4	4	10
26	13	14	2	5	35	30	31	35	30	28	5	3	5	5	5	5	12
27	16	12	2	1	33	33	37	32	26	27	5	3	2	5	5	5	10
28	13	—	2	3	32	32	26	24	31	30	5	3	4	5	5	5	10
29	11	10	3	3	32	32	31	24	29	30	5	3	5	5	5	5	10
30	15	16	0	3	37	32	30	31	27	31	5	3	5	5	5	5	12
31	13	14	5	3	30	36	33	27	32	31	5	3	5	5	5	5	11
32	16	16	5	2	35	34	29	30	28	26	5	3	5	5	5	5	9
33	11	13	5	4	28	34	25	24	19	34	5	3	5	5	5	5	11
34	13	12	3	1	36	33	31	33	30	30	5	3	5	5	5	5	11
35	0	13	—	4	34	33	32	27	25	29	5	3	5	5	5	5	11
36	14	16	3	5	37	32	34	31	26	30	4	3	5	5	6	5	12
37	0	—	4	5	34	37	29	30	30	29	4	3	6	4	6	3	11
	439	425	117	120	1199	1182	1040	1075	966	1028	128	105	144	121	115	151	355

TABLE 40 (Continued).—BOYS' SCORES

Boy	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	E18	F1	F2	F3	F4
1	10	—	—	40	31	19	31	30	42	—	—	27	35	93	83	105	49	2	—	—	—
2	8	22	6	19	15	10	25	28	30	12	13	25	30	68	65	91	49	0	0	2	2
3	8	18	15	44	38	38	38	28	34	15	14	35	38	89	78	104	47	1	2	5	3
4	10	—	—	44	29	14	35	28	36	14	13	26	35	75	75	113	45	3	—	4	3
5	8	26	—	21	23	9	3	24	24	8	10	28	28	73	73	97	51	1	2	3	3
6	9	25	14	18	23	22	11	24	28	12	14	19	28	73	66	98	49	1	1	0	3
7	9	23	15	26	33	33	30	30	30	5	11	31	37	97	90	104	43	2	2	4	3
8	9	18	13	18	13	7	8	20	23	4	10	24	28	51	64	95	45	0	1	1	2
9	8	22	8	21	18	17	18	26	34	10	15	27	29	73	64	96	48	0	1	2	2
10	10	21	14	36	30	35	39	29	40	9	9	25	31	91	81	105	47	2	0	4	3
11	7	24	11	27	24	14	29	24	39	8	11	23	27	82	76	101	50	1	0	3	2
12	9	17	14	26	29	14	11	21	30	9	8	24	25	74	65	96	49	2	3	4	2
13	4	21	17	29	27	21	14	26	24	12	9	34	32	91	74	108	51	2	4	1	5
14	8	10	—	27	30	18	34	28	35	15	14	23	33	83	81	92	46	2	1	2	3
15	4	18	10	32	29	15	11	27	37	15	14	27	31	93	79	91	47	1	2	4	3
16	12	21	12	28	26	29	36	28	29	10	11	23	24	83	72	88	45	1	1	4	1
17	10	20	15	22	24	14	16	28	33	8	11	28	32	78	73	98	44	0	2	5	2
18	10	15	8	34	29	38	39	29	33	8	14	31	31	97	—	114	43	1	2	—	—
19	7	15	—	18	10	6	7	11	27	10	—	23	22	64	64	75	42	0	2	2	3
20	4	—	—	37	27	15	34	22	36	6	—	29	35	71	72	103	—	2	—	0	—
21	7	2	10	25	22	20	14	23	28	8	11	31	31	71	70	95	48	0	1	3	2
22	4	19	15	21	22	23	20	28	24	4	6	23	27	73	60	83	45	1	1	0	2
23	8	19	9	29	29	13	25	28	36	8	10	22	30	83	68	72	—	1	1	2	2
24	8	22	9	25	19	29	25	25	24	7	14	29	28	76	73	103	43	0	1	2	3
25	11	11	8	33	28	17	22	30	46	9	14	28	34	82	70	105	—	0	0	3	2
26	11	24	12	33	29	35	33	22	38	10	12	32	31	85	75	98	48	1	1	0	3
27	7	15	13	31	7	23	34	23	26	4	6	25	29	59	75	98	48	2	2	—	3
28	7	—	15	24	30	1	11	24	32	9	7	30	29	82	76	105	51	1	—	—	—
29	7	17	8	22	21	11	8	24	32	4	5	19	22	76	63	91	47	0	1	0	0
30	8	20	13	35	35	29	34	26	34	12	11	33	36	86	83	102	48	2	2	4	3
31	11	19	12	40	32	22	31	24	32	13	13	25	23	81	71	104	46	1	1	0	2
32	9	19	13	24	28	20	16	28	35	12	10	26	26	79	74	99	49	1	1	1	1
33	7	24	10	26	23	12	16	22	32	8	11	32	28	76	71	107	41	1	1	3	3
34	8	27	12	26	30	25	21	21	31	13	14	30	29	82	71	99	52	0	1	1	3
35	8	17	12	31	30	22	13	20	32	—	14	27	29	89	75	100	48	1	—	0	—
36	9	19	11	41	36	18	35	30	36	11	13	37	35	91	81	94	45	1	3	—	5
37	7	23	15	29	30	26	36	20	33	10	10	25	27	83	62	89	50	0	1	1	3
	301	633	369	1062	959	734	863	929	1195	332	382	1006	1105	2953	2613	3618	1599	37	44	70	82

TABLE 41—GIRLS' SCORES

Girl	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14
1	11	9	7	5	2	7	25	20	11	8	0	0	188	211
2	27	28	4	3	..	13	24	20	18	20	..	15	216	208
3	9	2	5	3	9	4	..	..	..	..	..	..	214	210
4	0	1	1	0	..	4	9	12	9	19	2	0	223	236
5	19	0	1	3	2	9	17	17	19	18	0	9	206	226
6	2	2	2	1	6	12	26	18	15	20	19	27	231	239
7	0	6	6	3	6	1	22	18	14	15	15	22	217	209
8	6	20	5	4	4	10	23	31	20	20	13	6	224	235
9	14	8	7	2	13	9	31	18	16	20	25	29	213	235
10	0	2	0	0	0	2	27	18	12	19	1	2	235	244
11	6	10	2	2	6	5	20	14	16	..	0	0	217	219
12	9	4	4	1	12	..	..	..	..	..	..	..	...	...
13	19	16	5	2	5	19	27	18	17	17	8	20	214	207
14	27	25	3	3	2	4	21	45	15	12	1	1	221	233
15	9	2	7	6	0	2	37	22	12	17	4	6	230	219
16	..	..	5	1	3	15	32	30	18	20	4	1	205	201
17	19	16	5	6	1	1	38	23	14	13	7	6	235	229
18	9	10	0	2	5	9	28	9	18	14	0	0	220	234
19	16	3	0	1	9	6	29	18	19	8	2	12	213	230
20	4	17	1	2	1	4	27	27	20	20	11	11	210	214
21	6	3	1	2	0	4	18	17	12	10	0	0	205	197
22	9	25	0	2	15	22	37	23	18	20	27	29	204	216
23	11	19	4	2	14	20	..	37	..	20	5	2	231	233
24	16	7	3	3	8	12	22	34	15	18	22	30	231	231
25	9	0	3	1	6	13	23	17	18	8	9	13	241	231
26	23	5	6	6	15	24	28	23	20	20	26	18	198	219
27	16	0	1	3	6	4	22	13	18	17	2	7	214	207
28	8	4	2	2	10	18	25	23	15	14	15	25	230	216
29	18	6	6	3	4	4	22	18	12	9	8	4	207	206
30	16	6	4	4	6	10	25	22	20	20	9	12	223	236
31	10	12	2	3	1	6	26	23	20	17	..	5	232	226
32	0	0	2	1	0	2	21	14	17	5	..	..	228	238
33	2	4	..	..	3	6	24	11	..	14	8	15	247	227
34	3	8	2	4	..	3	12	23	20	19	9	6	230	244
35	9	10	4	3	6	6	19	9	9	11	1	9	195	219
36	17	4	2	3	14	28	35	19	18	19	11	10	203	212
37	..	..	..	..	..	10	21	13	18	..	..	29	215	216
38	27	5	1	4	7	10	24	23	20	19	5	21	209	227
39	6	2	1	3	7	10	18	15	11	19	8	11	236	237
40	0	8	1	1	2	3	25	18	10	9	14	19	211	216
41	16	1	2	2	2	5	5	16	..	..	..	..	210	215
42	8	4	2	2	0	9	..	..	15	20	..	2	202	226
43	17	4	4	2	6	15	17	24	13	20	14	20	217	226
44	26	24	10	6	11	18	16	8	20	..	..	..	218	210
45	11	4	2	3	5	18	22	18	16	19	20	29	226	226
46	8	7	2	2	16	..	..	..	20	20	21	27	208	214
	498	353	137	117	250	416	970	839	658	647	346	510	9803	10010

TABLE 41—GIRLS' SCORES

Girl	B1	B2	B3	B4	B5 (6)	B6 (5)	C1	C2	C3	C4	C5	C6	C7	C8
1	10	24	2	2	14	10	3	3	32	31	32	31	31	31
2	5	11	2	4	16	13	3	5	33	33	33	32	31	33
3	3	4	2	2	10	14	4	4	33	33	31	30	34	29
4	8	9	2	4	14	14	1	5	32	31	34	28	34	30
5	0	4	0	2	11	15	3	2	34	31	32	32	31	27
6	3	6	2	1	13	16	2	2	33	33	32	29	—	28
7	2	4	0	4	14	14	1	2	32	36	22	25	27	29
8	4	4	2	2	14	12	5	4	30	34	33	31	26	31
9	4	19	4	4	14	14	3	2	33	31	—	30	27	29
10	4	11	2	0	14	2	3	2	36	34	33	27	30	31
11	4	0	2	2	11	0	2	2	33	28	30	29	33	28
12	2	4	1	4	—	—	—	—	36	29	31	—	28	30
13	4	0	2	4	15	15	3	3	34	35	31	31	33	33
14	2	10	2	2	10	13	3	3	25	28	34	32	31	30
15	4	4	4	4	16	11	2	2	30	33	29	—	28	27
16	6	16	2	4	—	14	—	4	31	33	32	34	29	26
17	4	7	2	4	10	11	3	3	30	31	29	29	28	25
18	1	4	2	2	14	15	1	2	30	29	32	28	25	31
19	16	28	2	6	16	12	2	2	25	31	29	29	29	29
20	3	2	2	0	15	14	2	3	37	37	34	35	28	33
21	8	4	2	2	8	14	2	3	35	29	32	28	32	28
22	16	10	0	3	10	16	4	3	32	32	31	33	34	32
23	9	13	0	4	16	12	4	3	37	—	30	34	33	33
24	18	36	3	0	12	12	3	2	34	32	35	34	34	34
25	2	2	2	2	14	14	5	3	34	34	29	30	29	27
26	—	—	—	—	14	0	1	2	31	30	31	31	27	27
27	4	3	3	2	11	13	1	2	32	36	30	29	26	30
28	13	0	4	4	12	15	4	3	—	35	—	26	—	29
29	7	0	2	2	13	0	1	0	31	32	29	24	27	20
30	8	5	3	4	13	0	1	3	34	35	33	33	34	31
31	5	12	1	3	16	13	4	3	29	32	31	31	31	30
32	2	0	3	1	15	13	—	—	30	33	29	31	31	27
33	7	12	2	4	0	0	1	1	33	—	28	21	29	24
34	8	4	4	2	14	11	4	3	35	34	32	34	30	33
35	6	22	2	2	12	11	2	2	27	35	—	21	29	30
36	1	6	2	2	—	12	—	—	30	—	25	—	26	—
37	—	—	—	—	16	15	3	3	30	33	33	31	29	33
38	10	6	2	0	16	14	3	3	26	23	31	23	28	29
39	14	0	3	2	12	13	3	2	29	32	30	24	23	24
40	10	4	1	2	16	11	2	2	33	30	28	32	31	33
41	2	7	0	4	—	12	—	—	29	33	27	26	31	30
42	2	5	0	4	13	12	3	3	32	33	29	28	33	30
43	4	4	1	2	9	13	4	3	34	36	35	29	30	32
44	1	6	3	4	15	14	3	5	35	37	27	30	33	34
45	8	12	1	4	12	0	3	5	36	36	33	32	34	32
46	6	5	4	4	14	13	—	—	35	29	33	34	34	32
	260	349	87	120	544	502	107	114	1442	1392	1324	1271	1321	1334

TABLE 41—GIRLS' SCORES

Girl	D1	D2	D3	D4	D5	D6	E1	E2	E3	E4	E5	E6	E7	E8
1	2	4	5	4	4	4	10	11	21	12	23	26	16	16
2	5	4	6	3	5	5	12	3	23	18	35	39	34	36
3	5	5	—	—	3	3	12	7	—	—	32	27	34	35
4	5	3	3	4	4	4	12	6	20	9	15	21	15	16
5	2	1	1	3	0	4	10	8	9	11	16	17	20	20
6	4	3	5	4	3	4	11	8	20	14	23	20	20	16
7	2	1	3	2	0	3	8	9	25	14	24	19	16	13
8	5	5	6	5	4	5	10	8	18	—	40	40	36	37
9	4	3	4	4	2	2	10	10	25	13	32	28	36	36
10	3	4	4	2	4	4	12	7	15	9	21	24	14	28
11	3	1	3	4	4	3	10	9	—	6	22	22	19	30
12	—	—	—	—	4	3	—	—	—	—	28	25	28	—
13	3	3	4	3	2	4	10	6	11	7	25	25	22	25
14	3	3	4	3	2	4	9	9	26	10	21	19	12	19
15	2	2	3	4	3	2	6	6	19	10	—	—	17	21
16	5	4	4	3	4	5	11	9	18	13	25	25	29	26
17	2	2	3	1	3	5	—	6	20	20	—	26	19	13
18	2	0	2	2	3	4	10	9	21	15	16	19	12	24
19	4	3	2	4	2	4	11	8	18	11	33	28	25	28
20	3	4	4	5	3	5	7	8	11	5	21	21	13	18
21	2	4	5	5	4	4	10	9	20	17	31	27	20	19
22	3	5	5	3	2	3	11	10	19	9	28	25	29	32
23	4	3	5	6	4	5	8	11	12	—	28	33	35	36
24	2	2	4	4	4	3	10	8	19	15	18	12	8	18
25	1	2	3	3	2	3	11	11	18	2	33	27	26	18
26	0	0	3	5	3	3	10	6	21	8	25	20	17	24
27	4	2	5	4	2	2	10	8	22	6	24	20	16	11
28	4	4	4	4	3	3	12	10	22	6	38	36	—	31
29	1	0	2	2	2	4	10	4	13	6	13	15	13	17
30	4	1	4	5	1	3	12	9	22	13	26	31	20	27
31	2	3	4	5	1	3	10	10	18	9	35	31	13	0
32	—	—	6	4	2	4	7	10	13	—	18	12	15	1
33	0	0	1	1	0	2	9	8	—	6	—	—	14	13
34	5	3	6	4	4	5	11	9	18	12	32	29	28	34
35	4	2	3	2	3	5	9	10	18	8	26	28	31	33
36	—	—	4	3	5	3	—	10	14	9	20	11	14	10
37	4	3	5	4	5	5	5	8	16	10	31	28	33	34
38	1	3	3	2	0	2	12	5	20	12	—	—	6	9
39	1	1	2	3	2	3	11	6	13	10	23	22	12	12
40	2	4	4	4	4	4	11	8	23	7	20	22	16	13
41	—	—	—	—	3	3	—	8	—	—	28	25	10	19
42	4	3	2	5	5	4	11	10	18	13	—	—	21	19
43	5	3	5	3	5	2	12	4	28	13	28	27	31	34
44	4	3	6	6	4	5	12	10	22	—	44	38	38	37
45	3	4	5	3	4	4	10	8	24	14	38	32	35	33
46	—	—	5	3	5	5	11	11	10	6	25	26	32	39
	124	110	167	153	138	169	426	368	763	408	1084	1048	970	1030

TABLE 41—GIRLS' SCORES

Girl	E9	E10	E11	E12	E13	E14	E15	E16	E17	E18	F1	F2	F3	F4
1	28	25	10	12	26	31	83	77	101	48	0	2	1	2
2	27	32	13	14	31	33	86	78	92	51	1	1	4	3
3	26	32	13	14	27	29	93	65	70	48	2	—	1	3
4	27	34	9	13	25	26	78	71	88	47	2	2	3	3
5	22	30	6	10	29	29	78	75	88	46	1	0	2	0
6	27	28	9	12	20	27	72	66	64	49	0	2	0	2
7	30	22	9	12	25	31	74	71	87	46	0	3	5	2
8	32	40	12	13	37	36	94	78	112	46	2	2	4	3
9	26	32	14	12	24	28	82	68	99	48	0	4	3	3
10	29	29	10	10	20	28	80	67	89	46	1	2	3	3
11	20	30	11	11	27	29	75	63	96	46	0	—	2	2
12	23	36	—	—	22	27	79	70	—	44	—	—	—	—
13	26	28	15	12	25	26	74	61	80	51	1	1	3	1
14	20	22	11	10	27	30	57	67	89	44	1	0	2	1
15	26	28	9	9	26	30	74	64	89	42	2	2	4	3
16	30	28	11	12	28	26	78	67	99	49	0	1	3	5
17	28	33	7	9	20	24	69	65	71	42	1	2	2	3
18	24	25	6	9	24	20	70	62	73	45	4	1	3	2
19	26	26	15	14	28	32	78	70	97	49	1	2	3	5
20	28	37	12	13	24	26	71	65	92	49	2	2	3	3
21	29	39	14	9	28	29	78	69	96	47	3	2	2	3
22	27	44	10	12	31	34	92	74	105	47	2	1	4	2
23	27	40	12	14	27	30	84	69	79	—	4	3	3	2
24	26	32	8	14	23	27	60	63	71	47	0	0	4	3
25	23	28	11	11	35	39	98	79	99	48	2	0	5	3
26	28	21	12	13	28	23	64	62	86	45	1	0	0	3
27	22	24	9	11	21	25	73	68	85	47	2	1	0	2
28	28	34	9	11	27	33	98	77	113	48	2	4	4	5
29	28	20	6	5	22	18	53	56	93	48	0	0	0	3
30	28	29	8	7	29	29	79	67	99	46	2	1	2	5
31	30	40	15	13	24	29	88	78	95	44	3	1	0	3
32	22	29	—	—	24	27	61	60	75	—	2	2	1	3
33	19	23	14	10	20	18	72	67	72	44	0	0	0	0
34	32	32	13	14	25	34	75	68	80	47	2	1	0	3
35	28	26	9	9	29	35	81	72	95	51	2	2	0	3
36	24	28	—	10	19	25	74	64	76	44	0	0	—	3
37	32	27	8	13	19	27	—	70	90	45	2	1	2	2
38	24	20	9	12	26	22	76	67	82	44	2	1	2	3
39	18	30	8	12	23	25	65	62	77	37	0	2	2	2
40	14	24	9	11	19	26	78	63	87	43	2	1	3	1
41	22	36	—	—	25	28	78	73	78	48	0	—	—	—
42	26	36	13	11	18	29	95	82	112	—	3	2	4	3
43	21	30	8	—	25	27	87	69	101	48	1	2	0	2
44	32	46	14	—	35	36	98	92	116	50	4	2	6	3
45	32	32	11	13	24	26	94	71	106	48	0	0	0	3
46	26	38	—	13	33	30	76	73	93	51	2	2	3	5
	1193	1405	432	469	1174	1299	3522	3185	4037	2003	64	60	98	119

TABLE 42—BOYS' DEVIATIONS OF THE COMPOSITES

Boy	#A1	#A2	#B1	#B2	#C1	#C2	#D1	#D2	#E1	#E2	#F1	#F2
1												
2	69	101	—2	3	—6	10	4	—1	—12	—35	—1	—1
3	53	55	10	17	3	8	3	0	73	58	3	2
4												
5	—113	—126	—1	—12	—2	—1	1	—2	—10	—21	1	2
6	126	94	23	30	4	6	—1	—3	—13	—20	—2	1
7	—23	26	—9	—4	—7	0	—2	—2	62	36	3	2
8	—14	—32	—36	7	6	—6	2	0	—80	—65	—2	0
9	—37	—25	2	—11	10	5	2	—2	—2	—23	—1	0
10	36	—2	—14	—3	17	14	4	2	61	63	3	0
11	—91	—46	—4	—11	13	8	3	4	—3	25	1	—1
12	—144	—138	—14	—6	—25	—16	—1	—4	—48	—18	3	2
13	—37	—45	—2	—3	2	—1	—2	2	37	—20	0	0
14	86	101	10	18	—5	—1	—3	—3	—18	9	1	1
15	—82	—70	—18	—15	—3	—14	0	2	21	—2	2	2
16	53	39	—19	8	3	—9	1	1	15	5	2	—1
17	34	50	14	4	7	—3	—1	0	—1	5	2	1
18												
19	—100	—86	1	1	—2	0	—2	—1	—128	—89	—1	2
20												
21	—10	—38	2	5	—12	—17	—2	—1	—71	—34	0	0
22	32	37	16	—10	—3	—2	—5	—1	—34	—59	—2	0
23	90	31	—11	9	7	—5	0	—3	—22	2	0	0
24	9	6	13	19	7	11	—1	1	11	—45	—1	1
25	33	9	7	12	1	—4	2	2	4	44	0	—1
26	—12	—11	9	—14	7	10	1	—1	44	46	—2	1
27	16	22	12	12	—5	—3	3	2	—51	—28	2	2
28												
29	—30	—75	—24	—14	5	3	0	0	—47	—59	—3	—2
30	121	72	20	20	—12	—6	—4	—4	42	47	3	2
31	—31	—19	14	24	14	6	4	4	27	14	—2	0
32	53	55	6	5	5	7	2	2	11	10	—1	—1
33	—76	—108	—24	—6	—19	—11	—8	—5	3	—35	1	1
34	18	60	8	1	8	12	2	—1	29	9	—2	1
35												
36	4	28	8	12	6	6	1	1	52	45	3	5
37	—120	—43	—20	—5	4	10	5	—1	1	17	—2	1
	833	786	194	207	129	116	40	23	493	435	30	35
	—920	—864	—179	—114	—101	—99	—32	—35	—540	—553	—22	—7

TABLE 43—GIRLS' DEVIATIONS OF THE COMPOSITES

Girl	#A1	#A2	#B1	#B2	#C1	#C2	#D1	#D2	#E1	#E2	#F1	#F2
1	—24	—51	2	14	2	1	1	1	17	2	—2	0
2	61	71	3	13	4	10	6	1	58	61	2	0
3												
4	—124	—78	8	7	3	1	2	0	—12	—12	2	1
5	—28	—23	—6	—12	4	—4	—7	—3	—59	—10	0	—4
6	—4	24	7	—10	—2	—4	2	0	—37	—11	—3	0
7	—4	—19	—6	2	—16	—4	—5	—5	5	—27	2	1
8	18	56	0	—6	0	6	5	4	92	70	3	1
9	97	37	12	17	—2	—4	0	—2	51	33	0	3
10	—84	—66	—20	—7	6	—2	1	—1	—17	—16	1	1
11	—42	—53	—24	—16	1	—9	0	—3	—37	—18	—1	—2
12												
13	33	53	6	0	5	7	—1	—1	—37	—26	1	—2
14	—6	28	0	—8	—3	—2	—1	—1	—37	—44	0	—3
15	2	—22	6	6	—8	—6	—2	—3	—25	—35	3	1
16	17	17	6	18	1	3	3	1	28	4	0	2
17	29	—11	—2	—3	—6	—7	—2	—3	—38	—2	0	1
18	—27	—59	3	—6	—10	—6	—3	—5	—53	—29	4	—1
19	9	—70	12	38	—12	—5	—2	0	22	5	1	3
20	—15	22	3	—14	4	13	0	3	—48	—9	2	1
21	—86	—88	8	—18	4	—7	1	2	25	42	2	1
22	75	120	12	—4	6	5	0	0	47	60	3	—1
23	58	76	—3	15	9	12	3	3	—13	41	4	1
24	34	76	18	14	10	6	0	—2	—66	—7	1	—1
25	2	—55	2	—8	3	—1	—4	—3	39	—7	4	—1
26	127	88	—22	2	—8	—6	—4	—3	—10	—63	—2	—1
27	—12	—54	6	—13	—9	1	1	—3	—29	—57	—1	—1
28	10	34	23	—6	0	—2	1	0	81	34	3	5
29	4	—70	—21	—12	—10	—22	—5	—5	—66	—103	—3	—1
30	34	22	—16	1	4	7	—1	—2	28	6	1	2
31	—17	—8	—1	10	0	1	—3	0	25	16	0	0
32												
33												
34	—51	—9	10	—6	6	9	5	1	17	32	—1	0
35	—52	—56	0	8	—17	—8	0	—2	17	11	—1	1
36												
37												
38	31	36	10	—8	—8	—17	—6	—4	—26	—66	1	0
39	—53	—12	16	—14	—11	—14	—5	—4	—85	—55	—1	0
40	—58	—51	0	—2	—3	1	0	1	—46	—62	2	—2
41												
42	—61	—11	—10	1	1	—1	1	1	31	37	4	1
43	2	41	—2	—16	8	5	5	—3	44	2	—2	0
44	87	66	5	6	2	13	4	3	124	127	7	1
45	9	58	—24	6	10	12	2	0	87	33	—3	—1
46												
	739	925	178	178	93	113	43	21	838	616	53	27
	—748	—866	—157	—189	—125	—131	—51	—58	—741	—659	—20	—21

TABLE 44—ARITHMETIC AVERAGES

	Boys		Girls		Highest possible Score	
A1 & A2	17.17	15.61	11.32	8.02	55	55
A3 & A4	5.14	4.14	3.11	2.66	28	27
A5 & A6	6.06	8.69	5.95	9.45	35	35
A7 & A8	28.82	16.84	23.66	19.98	56	70
A9 & A10	15.47	16.31	16.05	16.18	20	20
A11 & A12	14.19	21.52	9.35	12.44	30	30
A13 & A14	208.64	210.57	217.84	222.44	288	288
B1 & B2	9.57	10.76	5.91	7.93	48	48
B3 & B4	3.05	2.35	1.98	2.73	10	8
B5 & B6	11.86	13.28	~~12.95~~ 17.76	~~14.16~~ 13.45	16	16
C1 & C2	3.34	3.43	2.68	2.78	5	5
C3 & C4	33.31	31.95	32.04	32.37	38	38
C5 & C6	29.71	29.05	30.79	29.56	35	35
C7 & C8	28.41	28.58	30.02	29.64	36	36
D1 & D2	3.66	3.00	3.02	2.68	5	5
D3 & D4	4.36	3.67	3.88	3.56	6	6
D5 & D6	3.11	4.08	3.00	3.67	6	6
E1 & E2	9.86	8.14	10.14	8.18	12	12
E3 & E4	19.18	11.90	18.61	10.46	37	20
E5 & E6	28.70	25.92	26.44	24.95	50	50
E7 & E8	18.84	23.32	21.56	22.89	40	40
E9 & E10	25.11	32.30	25.93	30.54		
E11 & E12	9.49	11.24	10.54	11.44	15	15
E13 & E14	27.19	29.86	25.52	28.24	43	43
E15 & E16	79.81	72.58	78.27	69.24	104	100
E17 & E18	97.78	47.03	89.71	46.58	130	54
F1 & F2	1.00	1.38	1.42	1.43	4	4
F3 & F4	2.19	2.56	2.28	2.70	5	7

TABLE 45

RELIABILITY COEFFICIENTS:

Paired Tests arranged according to the Groups

	Boys		Girls	
	n	*r*	*n*	*r*
A1 & A2	36	61	44	37
A3 & A4	37	62	44	56
A5 & A6	35	58	40	72
A7 & A8	34	41	41	24
A9 & A10	31	69	38	34
A11 & A12	29	76	37	84
A13 & A14	37	68	45	59
B1 & B2	37	67	44	48
B3 & B4	37	51	44	—07
B5 & B6	32	—18	42	27
C1 & C2	35	41	40	46
C3 & C4	36	29	42	38
C5 & C6	35	,50	40	48
C7 & C8	33	34	43	45
D1 & D2	35	20	41	55
D3 & D4	33	16	43	44
D5 & D6	37	27	46	42
E1 & E2	36	31	42	—15
E3 & E4	30	21	37	41
E5 & E6	37	65	41	86
E7 & E8	37	65	44	82
E9 & E10	37	40	46	34
E11 & E12	33	61	39	43
E13 & E14	37	62	46	65
E15 & E16	36	66	45	77
E17 & E18	34	05	42	26
F1 & F2	32	30	42	32
F3 & F4	30	19	43	14

TABLE 46

RELIABILITY COEFFICIENTS:

Paired Tests arranged according to Magnitude of the Coefficient

Boys	*r*	Girls	*r*
A11 & A12	76	E5 & E6	87
A9 & A10	69	A11 & A12	84
A13 & A14	68	E7 & E8	82
B1 & B2	67	E15 & E16	77
E15 & E16	66	A5 & A6	72
E7 & E8	65	E13 & E14	65
E5 & E6	65	A13 & A14	59
A3 & A4	62	A3 & A4	56
E13 & E14	62	D1 & D2	55
A1 & A2	61	B1 & B2	48
E11 & E12	61	C5 & C6	48
A5 & A6	58	C1 & C2	46
B3 & B4	51	C7 & C8	49
C5 & C6	50	D3 & D4	44
C1 & C2	41	E11 & E12	43
A7 & A8	41	D5 & D6	42
E9 & E10	40	E3 & E4	41
C7 & C8	34	C3 & C4	38
E1 & E2	31	A1 & A2	37
F1 & F2	30	A9 & A10	34
C3 & C4	29	E9 & E10	34
D5 & D6	27	F1 & F2	32
E3 & E4	21	B5 & B6	27
D1 & D2	20	E17 & E18	26
F3 & F4	19	A7 & A8	24
D3 & D4	16	F3 & F4	14
E17 & E18	05	B3 & B4	—07
B5 & B6	—18	E1 & E2	—15

TABLE 47

Reliability Coefficients of the Composites arranged according to the Groups

	Boys		Girls	
#A1 & #A2	31	90	38	77
#B1 & #B2	31	55	38	17
#C1 & #C2	31	70	38	69
#D1 & #D2	31	56	38	70
#E1 & #E2	31	82	38	80
#F1 & #F2	31	39	38	24

TABLE 48

Reliability Coefficients of the Composites arranged according to the Magnitude of the Coefficients

Boys		Girls	
#A1 & #A2	90	#E1 & #E2	80
#E1 & #E2	82	#A1 & #A2	77
#C1 & #C2	70	#D1 & #D2	70
#D1 & #D2	56	#C1 & #C2	69
#B1 & #B2	55	#F1 & #F2	25
#F1 & #F2	39	#B1 & #B2	17

TABLE 49

RAW CORRELATIONS OF THE MANIPULATIVE TESTS

Boys	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14
A1		61	27	25	42	26	41	16	52	36	31	19	—35	—39
A2	61		37	13	36	25	45	23	28	10	17	09	—10	—22
A3	27	37		62	09	15	30	33	33	16	26	05	—08	—08
A4	25	13	62		17	38	44	18	34	15	48	26	—22	—29
A5	42	36	09	17		58	24	30	39	35	44	20	—25	—33
A6	26	25	15	38	58		31	27	49	38	68	54	—24	—17
A7	41	45	30	44	24	31		41	46	15	22	23	—13	—18
A8	16	23	33	18	30	27	41		40	05	15	—01	07	—05
A9	52	28	33	34	39	49	46	40		69	53	22	—02	—11
A10	36	10	16	15	35	38	15	05	69		51	21	37	21
A11	31	17	26	48	44	68	22	15	53	51		76	—17	—22
A12	19	09	05	26	20	54	23	—01	22	21	76		—13	03
A13	—35	—10	—08	—22	—25	—24	—13	07	—02	37	—17	—13		68
A14	—39	—22	—08	—29	—33	—17	—18	—05	—11	21	—22	03	68	

TABLE 50

RAW CORRELATIONS OF THE MANIPULATIVE TESTS

Girls	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14
A1		37	34	51	29	39	09	22	36	11	—01	08	—29	—24
A2	37		27	28	16	23	22	41	26	18	11	—03	—08	—14
A3	34	27		56	14	12	12	08	—03	—02	17	02	—12	—28
A4	51	28	56		04	10	18	09	19	07	05	—04	—11	—15
A5	29	16	14	04		72	22	05	37	36	58	53	—16	—10
A6	39	23	12	10	72		25	15	37	42	50	40	—16	—15
A7	09	22	12	18	22	25		24	16	08	26	14	—03	—10
A8	22	41	08	09	05	15	24		17	27	18	—05	08	14
A9	36	26	—03	19	37	37	16	17		34	26	20	01	02
A10	11	18	—02	07	36	42	08	27	34		41	26	03	14
A11	—01	11	17	05	58	50	26	18	26	41		84	02	04
A12	08	—03	02	—04	53	40	14	—05	20	26	84		05	—02
A13	—29	—08	—12	—11	—16	—16	—03	08	01	03	02	05		56
A14	—24	—14	—28	—15	—10	—15	—10	14	02	14	04	—02	56	

TABLE 51

RAW CORRELATIONS OF THE SPATIAL RELATIONS TESTS

Boys	B1	B2	B3	B4	B5	B6
B1		67	16	33	13	13
B2	67		12	22	30	—09
B3	16	12		51	30	—10
B4	33	22	51		28	08
B5	13	30	30	28		—18
B6	13	—09	—10	08	—18	

Girls	B1	B2	B3	B4	B5	B6
B1		48	15	04	—07	—03
B2	48		00	09	—02	02
B3	15	00		—07	—03	08
B4	04	09	—07		—04	02
B5	—07	—02	—03	—04		27
B6	—03	02	08	02	07	

TABLE 52

RAW CORRELATIONS OF THE COMPUTATIONAL ARITHMETIC

Boys	C1	C2	C3	C4	C5	C6	C7	C8
C1		41	13	21	—03	31	14	24
C2	41		23	08	13	27	11	11
C3	13	23		29	64	55	54	43
C4	21	08	29		38	50	23	44
C5	—03	13	64	38		50	47	37
C6	31	27	55	50	50		43	47
C7	14	11	54	23	47	43		34
C8	24	11	43	44	37	47	34	

Girls								
C1		46	10	06	23	29	19	31
C2	46		18	24	30	38	45	52
C3	10	18		38	20	42	38	38
C4	06	24	38		—10	10	05	22
C5	23	30	20	—10		48	28	35
C6	29	38	42	10	48		41	54
C7	19	45	38	05	28	41		45
C8	31	52	38	22	35	54	45	

TABLE 53

RAW CORRELATIONS OF THE ARITHMETIC PROBLEMS

Boys	D1	D2	D3	D4	D5	D6
D1		20	25	38	31	—04
D2	20		40	05	32	16
D3	25	40		16	45	22
D4	38	05	16		35	19
D5	31	32	45	35		27
D6	—04	16	22	19	27	

Girls	D1	D2	D3	D4	D5	D6
D1		55	57	33	51	34
D2	55		69	37	45	34
D3	57	69		44	49	34
D4	33	37	44		29	23
D5	51	45	49	29		42
D6	34	34	34	23	42	

TABLE 56

RAW CORRELATIONS OF THE LOGICAL TESTS

Boys	F1	F2	F3	F4
F1		30	21	36
F2	30		24	38
F3	21	24		19
F4	36	38	19	

Girls	F1	F2	F3	F4
F1		32	30	02
F2	32		35	18
F3	30	35		14
F4	02	18	14	

TABLE 54—RAW CORRELATIONS OF THE VERY VERBAL TESTS

Boys	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	E18
E1		31	04	—30	44	51	17	35	37	51	44	48	27	35	42	29	13	00
E2	31		04	—15	21	21	28	32	26	32	14	33	—11	01	14	18	22	—19
E3	04	04		21	—12	09	09	02	—02	—09	06	05	02	—10	12	02	11	21
E4	—30	—15	21		08	29	20	01	—14	—29	04	—37	13	15	12	25	15	22
E5	44	21	—12	08		64	43	70	37	56	38	28	44	56	53	55	46	—04
E6	51	21	09	29	64		42	41	45	52	47	29	44	50	82	55	34	15
E7	17	28	09	20	43	42		65	32	11	12	26	33	32	53	38	30	—12
E8	35	32	02	01	70	41	65		44	43	19	24	24	47	41	45	27	—16
E9	37	26	—02	—14	37	45	32	44		40	16	19	20	54	52	47	29	—05
E10	51	32	—09	—29	56	52	11	43	40		32	32	10	40	50	37	22	10
E11	44	14	06	04	38	47	12	19	16	32		61	20	22	39	26	11	25
E12	48	33	05	—37	28	29	26	24	19	32	61		28	38	30	22	25	—16
E13	27	—11	02	13	44	44	33	24	20	10	20	28		62	42	51	49	—04
E14	35	01	—10	—5	56	50	32	47	54	40	22	38	62		43	66	44	—02
E15	42	14	12	12	53	82	53	41	52	50	39	30	42	43		66	32	05
E16	29	18	02	25	55	55	38	45	47	37	26	22	51	66	66		49	—05
E17	13	22	11	15	46	34	30	27	29	22	11	25	49	44	32	49		05
E18	00	—19	21	22	—04	15	—12	—16	—05	10	25	—16	—04	—02	05	—05	05	

TABLE 55

Girls																		
E1		—15	26	14	19	30	10	18	—06	15	05	02	23	13	40	27	20	20
E2	—15		—11	—22	18	05	18	04	11	33	23	10	18	44	30	37	24	16
E3	26	—11		41	31	26	11	10	—02	—18	02	01	02	10	22	19	27	—02
E4	14	—22	41		14	16	12	07	30	14	—10	07	—13	—06	—04	04	—17	—09
E5	19	18	31	14		86	72	51	47	52	62	43	48	63	77	69	57	25
E6	30	05	26	16	86		73	63	42	52	48	30	53	59	76	67	60	30
E7	10	18	11	12	72	73		82	41	45	35	36	45	54	70	46	47	47
E8	18	04	10	07	51	63	82		38	35	19	27	49	44	46	29	42	43
E9	—06	11	—02	30	47	42	41	38		34	19	20	26	31	31	34	35	39
E10	15	33	—18	14	52	52	45	35	34		35	30	36	44	55	55	36	20
E11	05	23	02	—10	62	48	35	19	19	35		43	25	28	30	31	22	30
E12	02	10	01	07	43	30	36	27	20	30	43		20	31	31	29	—03	24
E13	23	18	02	—13	48	53	45	49	26	36	25	20		65	41	48	48	42
E14	13	44	10	—06	63	59	54	44	31	44	28	31	65		62	68	52	35
E15	40	30	22	—04	77	76	70	46	31	55	30	31	41	62		77	62	33
E16	27	37	19	04	69	67	46	29	34	55	31	29	48	68	77		65	34
E17	20	24	27	—17	57	60	47	42	35	36	22	—03	48	52	62	65		26
E18	20	16	—02	—09	25	30	47	43	39	20	30	24	42	35	33	34	26	

TABLE 57

CORRELATIONS OF THE PAIRED TESTS CORRECTED BY THE FORMULA FOR ATTENUATION

	BOYS						GIRLS					
	A1-2	A3-4	A5-6	A7-8	A9-10	A11-12	A1-2	A3-4	A5-6	A7-8	A9-10	A11-12
A1 & 2		39	53	57	42	25		75	48	69	58	06
A3 & 4	39		29	59	35	29	75		14	30	12	07
A5 & 6	53	29		57	63	63	48	14		34	76	64
A7 & 8	57	59	57		37	25	69	30	34		55	25
A9 &10	42	35	63	37		47	58	12	76	55		51
A11&12	25	29	63	25	47		06	07	64	25	51	

TABLE 58

	BOYS			GIRLS		
	B1-2	B3-4	B5-6	B1-2	B3-4	B5-6
B1 & 2		33	49		35	—07
B3 & 4	33		84	35		10
B5 & 6	49	84		—07	10	

TABLE 59

	BOYS				GIRLS			
	C1-2	C3-4	C5-6	C7-8	C1-2	C3-4	C5-6	C7-8
C1 & 2		42	38	37		31	64	75
C3 & 4	42		132	124	31		36	47
C5 & 6	38	132		105	64	36		83
C7 & 8	37	124	105		75	47	83	

TABLE 60

	BOYS			GIRLS		
	D1-2	D3-4	D5-6	D1-2	D3-4	D5-6
D1 & 2		112	81		95	85
D3 & 4	112		137	95		76
D5 & 6	81	137		85	76	

TABLE 61

Boys	E1&2	E3&4	E5&6	E7&8	E9&10	E11&12	E13&14	E15&16	E17&18
E1 & 2		—34	70	59	100	72	27	52	21
E3 & 4	—34		20	13	—32	—14	12	26	160
E5 & 6	70	20		74	93	55	76	92	66
E7 & 8	59	13	74		56	31	52	67	21
E9 &10	100	—32	93	56		48	51	91	63
E11&12	72	—14	55	31	48		42	45	34
E13&14	27	12	76	52	51	42		78	64
E15&16	52	26	92	67	91	45	78		57
E17&18	21	160	66	21	63	34	64	57	
Girls									
E1 & 2		14	50	37	139	74	97	108	364
E3 & 4	14		35	17	17	00	—03	17	—01
E5 & 6	50	35		77	88	73	74	88	84
E7 & 8	37	17	77		75	48	65	57	96
E9 &10	139	17	88	75		66	71	82	105
E11&12	74	00	73	48	66		49	52	53
E13&14	97	—03	74	65	71	49		75	106
E15&16	108	17	88	57	82	52	75		103
E17&18	364	—01	84	96	105	53	106	103	

TABLE 62

	Boys F3&4	Girls F3&4
F1 & 2	120	61

TABLE 63—BOYS

RAW CORRELATIONS OF THE COMPOSITES

	Manipulative		Non-Verbal Spatial		Non-Verbal Computation		Verbal Arithmetic		Very-Verbal		Logical	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Manipulative (1)	..	90	55	65	18	18	—05	—08	25	27	03	—19
(2)	90	..	60	61	24	36	11	02	33	34	01	—13
Non-Verbal Spatial (1)	55	60	..	55	12	20	—05	09	23	24	07	09
(2)	65	61	55	..	07	09	04	02	08	17	07	07
Non-Verbal Computation (1)	18	24	12	07	..	70	60	61	29	26	—33	—22
(2)	18	36	20	09	70	..	53	31	40	29	—33	—09
Verbal Arithmetic (1)	—05	11	—05	04	60	53	..	56	17	33	—11	—25
(2)	—08	02	09	02	61	31	56	..	18	18	—07	—09
Very-Verbal (1)	25	33	23	08	29	40	17	18	..	82	38	26
(2)	27	34	24	17	26	29	33	18	82	..	51	12
Logical (1)	03	01	07	07	—33	—33	—11	—07	38	51	..	39
(2)	—19	—13	09	07	—22	—09	—25	—09	26	12	39	..

TABLE 64—GIRLS

Manipulative (1)	..	77	03	32	04	22	01	00	31	22	09	09
(2)	77	..	12	14	39	51	28	26	33	39	12	00
Non-Verbal Spatial (1)	03	12	..	17	—04	08	13	18	05	20	30	32
(2)	32	14	17	..	—04	26	16	26	30	29	13	39
Non-Verbal Computation (1)	04	39	—04	—04	..	69	52	52	28	48	12	—11
(2)	22	51	08	26	69	..	68	67	47	63	32	05
Verbal Arithmetic (1)	01	28	13	16	52	68	..	70	55	64	12	28
(2)	00	26	18	26	52	67	70	..	50	68	34	28
Very-Verbal (1)	31	33	05	30	28	47	55	50	..	80	31	48
(2)	22	39	20	29	48	63	64	68	80	..	48	39
Logical (1)	09	12	30	13	12	32	12	34	31	48	..	25
(2)	09	00	32	39	—11	05	28	28	48	39	25	..

TABLE 65—CORRELATIONS OF THE COMPOSITES CORRECTED BY THE FORMULA FOR ATTENUATION

Boys	#A	#B	#C	#D	#E	#F	Girls	#A	#B	#C	#D	#E	#F
#A		86	29	01	34	—11			30	29	19	39	10
#B	86		18	05	25	16		30		14	50	46	128
#C	29	18		80	41	—41		29	14		86	61	21
#D	01	05	80		31	—24		19	50	86		79	57
#E	34	25	41	31		49		39	46	61	79		92
#F	—11	16	—41	—24	49			10	128	21	57	92	

SECTION VII

BIBLIOGRAPHY

BONSER, FREDERICK G. (1910) The Reasoning Ability of School Children of the Fourth, Fifth, and Sixth School Grades. (Contributions to Education, No. 37.) Teachers College, Columbia University.

BRIGGS, THOMAS HENRY (1913) Formal English Grammar as a Discipline. *Teachers College Record,* September, 1913.

BURT, CYRIL AND MOORE, ROBERT C. (1912) The Mental Differences between the Sexes. *Journal of Experimental Pedagogy,* 1912, pages 273 to 284 and 355 to 388.

DE FURSAC, J. ROGUES (1913) Manual of Psychiatry. John Wiley and Sons.

GODDARD, HENRY H. (1911) The Binet-Simon Measuring Scale for Intelligence. Revised Edition.

HART, BERNARD AND SPEARMAN C. (1912) General Ability, Its Existence and Nature. *British Journal of Psychology,* Vol. V.

SPEARMAN, C. (1904) General Intelligence objectively determined and measured. *American Journal of Psychology,* Vol. XV, No. 2.

(1914) The Theory of Two Factors. *Psychological Review.*

STARCH, DANIEL (1915) The Measurement of Achievement in English Grammar. *Journal of Educational Psychology,* December, 1915, p. 615ff.

(1916) A Scale for Measuring Ability in Arithmetic. *Journal of Educational Psychology,* April, 1916, pp. 213ff.

THOMPSON, HELEN B. (Mrs. Woolley) (1903) Psychological Norms in Men and Women. University of Chicago Contributions to Philosophy, Vol. 4, No. 1.

THORNDIKE, EDWARD LEE (1914) Educational Psychology, 3 vols. Teachers College, Columbia University.

(1914) The Measurement of Ability in Reading. *Teachers College Record,* September, 1914.

WOODWORTH, R. S. AND WELLS, F. L. (1911) Association Tests. *Psychological Review Monographs,* Vol. 13, 1911, No. 57.

WOODY, CLIFFORD (1916) Measurements of Some Achievements in Arithmetic. (Contributions to Education, No. 80.) Teachers College, Columbia University.

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